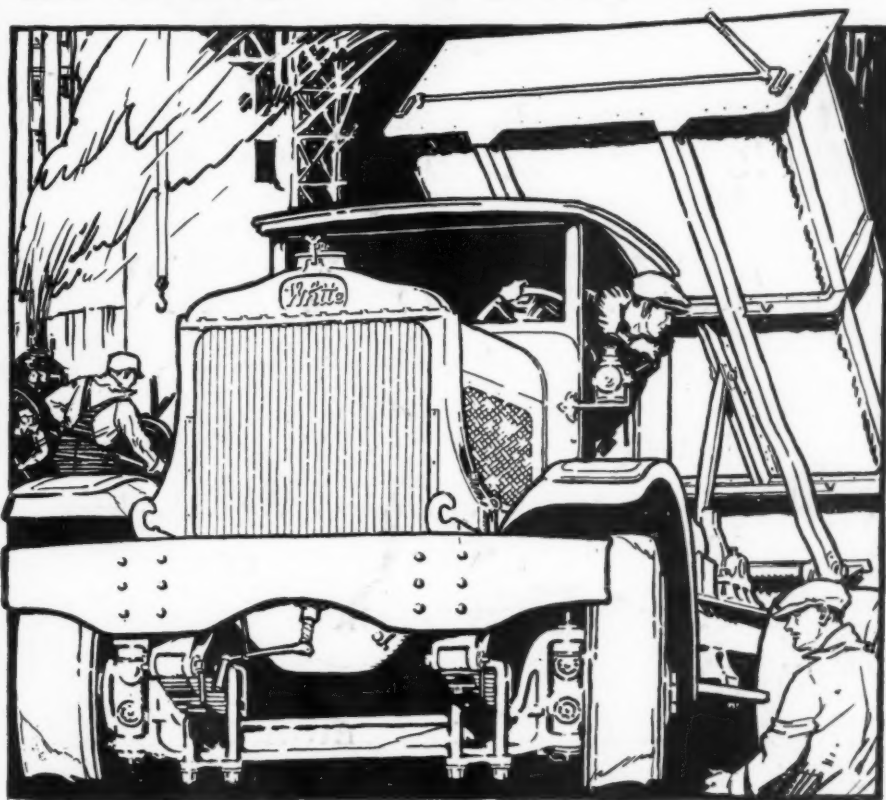


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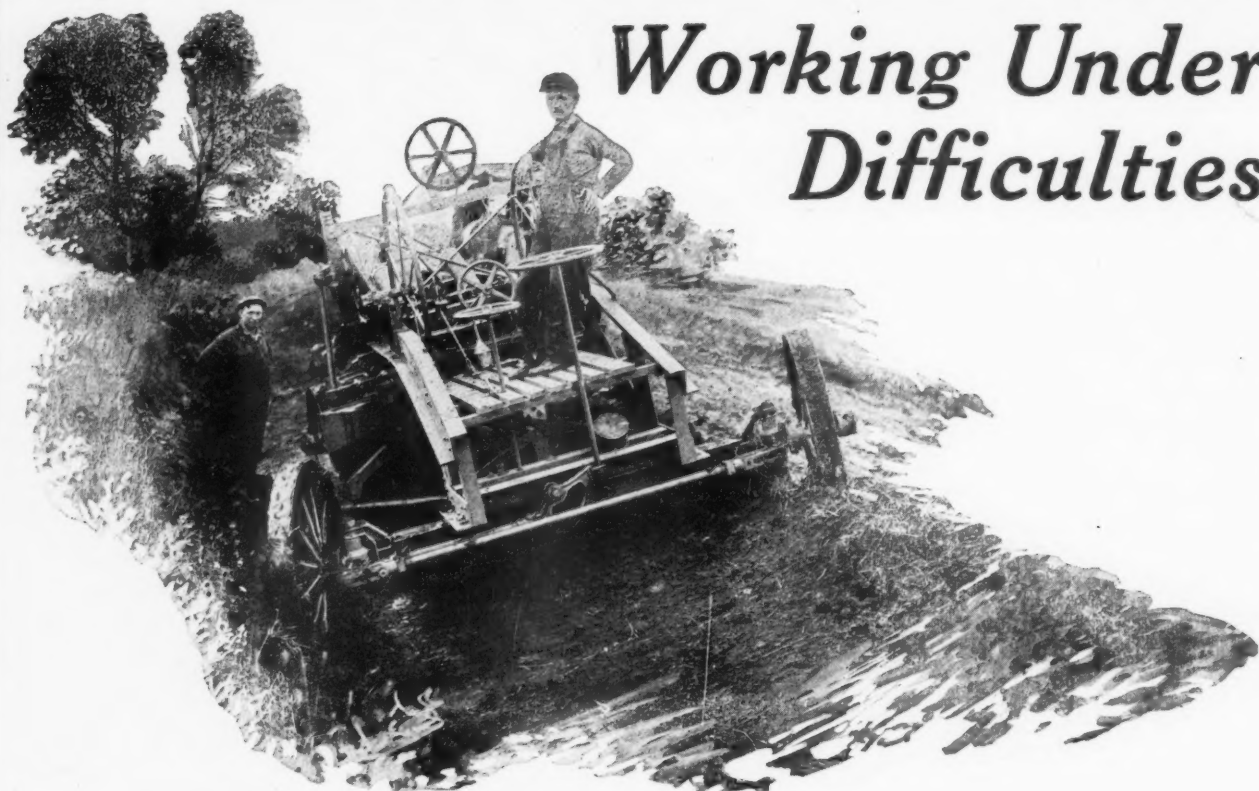
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PUBLIC WORKS

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 57

January, 1926

No. 1

Tampa's New Waterworks

New municipal surface supply, softened, decolored and filtered and pumped to standpipes, has been substituted for privately owned well supply which had become inadequate and unsatisfactory.

Tampa, Florida, will probably place in service before the end of February a waterworks plant which contains many points of interest to engineers and waterworks superintendents. Especially notable are some of the features connected with the selection of the new supply, the methods of treating the water to eliminate objectionable characteristics, and ornamental and other points of design of the buildings.

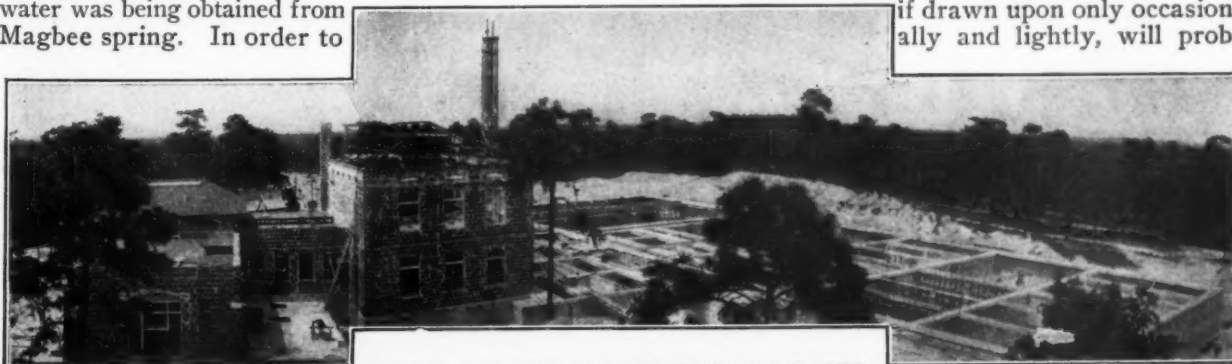
The plant is really an extension and improvement of a plant which has been in use for a great many years under the ownership of a private company. This plant is being taken over by the city at a cost of \$1,377,000. The new plant is estimated to cost about one and one-quarter million dollars, not including some extensions of the distribution system which may be necessary.

The Tampa Waterworks Co. had, up to 1922, built three pumping stations but only one was then in use, this containing one 3 m.g.d. triple-expansion pump, and two 5 m.g.d. triple-expansion pumps. In addition, there were four sub-stations containing electrically operated pumps, drawing water from additional wells which had been built between the years 1916 and 1921. The main supply was drawn from 10-inch wells, of which 30 had been sunk, but only 20 are now in use; these wells being 165 ft. to 328 ft. deep. The water obtained from these wells was hard in the dry season of the year, and with the increased draught was becoming very unpalatable from salinity. In addition, some water was being obtained from Magbee spring. In order to

reduce the draught upon the wells during days or hours of maximum consumption, a 3½ million gallon concrete storage reservoir had been built in 1916. Normal pressure was maintained by continuous pumping at 65 pounds, which was increased to 95 pounds, when necessary for fire fighting, by means of a pump in station number 3.

The population of Tampa and its environs, and of West Tampa, by the census of 1920 was given as 65,589. The consumption of water was probably about 9½ million gallons per day, this including about 1½ million gallons that was pumped by various industries from their own wells.

Realizing that the water from the wells was at no time of satisfactory quality and that the additional wells sunk during the previous five years had done little to improve conditions, the city in 1922 employed Nicholas S. Hill of New York City to report on the possibilities of securing a larger quantity and more acceptable quality of water, with a view to constructing a municipal system. Mr. Hill presented a report in December, 1922, and following further investigations, a supplementary report in June, 1923. Mr. Hill's plans and recommendations were adopted, and, under his supervision, a new source of supply has been developed to be distributed through the existing distribution system, which has been purchased from the private company. The new supply can be supplemented in times of maximum draught by the existing wells which, if drawn upon only occasionally and lightly, will prob-



Filter House and Office.

GENERAL VIEW OF PURIFICATION GROUP
Chemical House and Mixing Tanks.

Settling Basins.

ably deliver a much more satisfactory quality of water than at present. Mr. Hill estimated that by 1950 the population will have reached 203,000 and the consumption of 26,200,000 gallons per day, with a daily maximum of 37,000,000 gallons.

SOURCE OF SUPPLY

A number of sources of supply were considered, among these the driving of a number of new wells, possibly to other strata; the flow of two large springs located at some distance from the city; and using water from the Hillsboro river, which flows through the city. There were a number of other suggestions, but only these seemed worthy of detailed consideration.

The well water supply appeared to be perfectly safe, but analyses made during 1922 showed alkalinity ranging from 140 to 170, total hardness from 351 to 714 and salinity from 820 to 1470. Moreover, of 140 wells in Tampa and vicinity that were examined, three-quarters of them were unsatisfactory and the remainder would probably have become so under constant use. It appeared certain therefore that it would be necessary to soften the well water if it were to be rendered palatable.

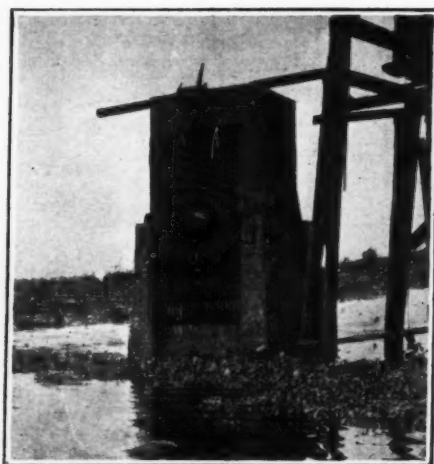
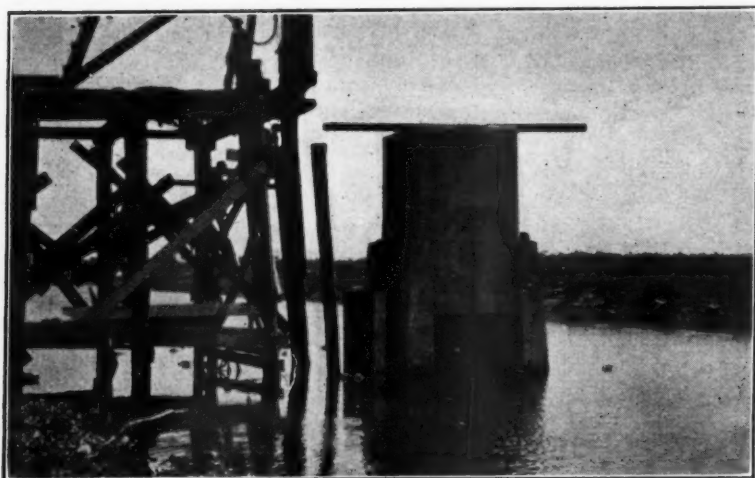
A spring known as Lithia spring, 15 miles southwest of the Tampa city hall, had been considered by the city, and an option had been obtained for purchasing it for \$100,000. At the time of the investigation a flow of about 30 million gallons per day was measured, which agreed very closely with a gauging made several years previous. Analysis showed no indication of pollution, turbidity or color. The permanent hardness was 63 to 99 p.p.m. and the alkalinity 106 to 138. It would be quite expensive to soften this water and pump it 15 miles to the city. Another large spring considered. Crystal spring, would have involved even more expense.

The Hillsboro river was ultimately adopted for the supply. It has a drainage area of 535 square miles above Tampa and it was believed safe to estimate a yield of 50 million gallons per day in a dry year, although 35 million was used to allow a factor of

safety. In May 1922, after very dry weather, the actual flow was gauged at 14½ million gallons per day; but a dam 20 feet high which had already been constructed across the river 5½ miles west of the city hall provides storage ample to maintain the consumption at the average of 35 m. g. d. This dam was owned by the Tampa Electric Co., with which the city has made arrangements permitting it to withdraw water above the dam, where the conditions are more favorable than below the dam for locating an intake to serve in both high and low water.

The water shed of the river is chiefly swamp land and pine timber flats and there is little danger of human pollution. During the rainy season, however, the water overflows the low land and becomes highly colored by contact with palmetto roots. (In May, 1922, the color was only 26, but in June this had increased to 168.) The hardness, on the other hand, reaches a maximum approximating 200 p. p. m. during the dry season when most of the flow of the river is derived from springs rising out of limestone rock, while during the wet season the surface water lowers the hardness to about 30 parts. Thus the period of maximum hardness coincides approximately with that of minimum color and vice versa. In order to render this supply palatable and pleasing, it was believed necessary to decolor, filter and soften all water, and the plant now reaching completion is designed to secure, as normal standards, a hardness of 100 p.p.m., alkalinity of 55 parts, chlorine 10, and color 6, which, says Mr. Hill, would give the city "one of the best and softest water supplies in the state of Florida."

The water in the river above the dam is about 20 feet above sea level, while the highest ground in Tampa is about 54 feet. It was thought desirable to maintain in the distribution system an hydraulic plane at elevation 170 in Tampa, and 140 in West Tampa where the land is lower and confined almost exclusively to residences. To secure this, three elevated tanks have been constructed, two in Tampa and one in West Tampa, each with a capacity of 500,000 gallons. With the 3½ million-gallon storage reservoir already in service, this gives a storage of 5 million gallons.



INTAKE IN HILLSBOROUGH RIVER, UP-STREAM FACE.

DOWN-STREAM FACE.

Shortly before these photographs were taken, high water had washed out the dam. With the dam in, the water stands nearly to the top of the highest screen.

The pumping and purification plants are designed for 12 million gallons per day with provision for 25 percent overload. The pipe line from the pumping plant to the city is designed to carry 15 m. g. d. or the capacity of the plant with a 25 percent-overload. There is also available 6 million gallons per day from the present wells, which will be maintained in service as a reserve. This provides for more than the 18 million gallons per day which is estimated to be the maximum weekly consumption by the year 1935. When this maximum has been reached, the pumping and purification plant can be increased to double the present capacity.

THE NEW PLANT

The new supply is taken in through an intake chamber constructed in the channel of Hillsboro river, from which an intake pipe carries the water to a suction well. From this the low-lift pumps pump the raw water to mixing tanks, where lime is added before the water enters the settling basins. From the basins the softened and clarified water is passed through other mixing tanks, first receiving a dose of alum and sulphurous acid, when it is passed onto rapid sand filters. After passing through these, it flows to a filtered water reservoir.

The several features of the plant are so located as to elevation that, after having been pumped into the first mixing tanks, the water flows by gravity through the structures above named to the filtered water reservoir, the water surface elevation of which is 31.5. From this reservoir, the high-lift pumps pump the water to the city against the head furnished by the elevated tanks. Both sets of pumps are operated by boilers using fuel oil. The small amount of current required for lighting the buildings and grounds, operating chemical elevators, and other motors is generated in the pumping station.

Removal of suspended matter, including that produced by the softening treatment, is provided for by the settling basins and filtration after treatment with alum. As an additional safeguard against pathogenic bacteria, the water, on leaving the plant, receives a small amount of liquid chlorine. To prevent clogging of the filter sand, carbon dioxide is applied to the water as it enters the filters. These processes follow in general the most advanced standard practice. The problem of removing the color in times of wet weather was not so easily solved. After a series of tests continued through several months, Mr. Hill decided to adopt a sulphur dioxide treatment, which it is expected will serve the desired purpose.

The structures provided include an intake chamber in the river; an intake pipe leading to a suction well; boiler house; pump house; fuel oil tanks; and filtered water reservoir. Just west of this group lie the mixing tanks, settling basins, chemical house, and filters. South of the pump house is a wash-water tank.

The plant is on the west bank of the Hillsboro river about three-quarters of a mile above the dam. About the same distance from the plant is the Tampa Northern Railroad, and a spur from this was laid for bringing fuel oil and chemicals to the plant. A drain for removing sludge and waste waters is carried from the plant to a point in the river about 3500 feet below the dam. About three miles of 30-

inch force main connects the pumping station with the distribution system in the city.

INTAKE CHAMBER AND SUCTION WELL

The intake chamber is of reinforced concrete with the bottom of its base at elevation minus 1.0 and the top at elevation 26.0. It is 5 feet square inside with 12-inch walls. In the upstream, downstream and off-shore faces are 4x4 foot openings, their bottoms 4 feet, 15 feet and 9.5 feet respectively above the river bottom. Each opening is provided with a sluice gate. In front of each opening is a bar screen to intercept floating grassy vegetable matter, of which there are at times large amounts in the river. These screens are 11 feet high and 6 feet wide, formed of 2"x1/2" bars spaced 3 inches centers. This chamber was built inside a cofferdam of steel sheet piling.

From elevation 1.0 at this chamber a 36-inch cast iron intake pipe slopes continuously upward for 260 feet to an elevation of 9.0 at the suction well.

In the suction well are three pairs of screens made of 1/4-inch mesh copper wire, each screen provided at the bottom with a galvanized iron basket to catch the screenings. A chain trolley block travels on a 12-inch I-beam as a track, which is set above the line of screens and extends through a doorway so that any screen can be raised from the well, run outside the building and cleaned by water from a hose.

PUMPING PLANT

There are two low-lift pumps, one of 8700 g. p. m. capacity, the other 4500 g. p. m.; each a condensing steam turbine driven centrifugal, operating against a head of 35 feet. These furnish circulating water as well as raw water to the purification plant. The high-lift pumps comprise two condensing steam turbine driven centrifugals, each with a capacity of 7000 g.p.m. against a head of 240 feet, and one of the same type with a capacity of 3500 g.p.m. There are also two electrically driven centrifugal wash-water pumps, each of 350 g.p.m. capacity. All pumps were manufactured by the DeLaval Steam Turbine Co. Electric current is furnished by two 50 k.w. generators, each driven by a crank and fly-wheel steam engine.

Steam for this machinery is furnished by three 200 h.p. Babcock and Wilcox water-tube oil-burning boilers, working pressure 175 lbs. with 100 degrees superheat. Each boiler is heated by two W. N. Best Co. oil burners. Oil is stored in two 25,000 gallon steel storage tanks. The boiler room contains a large window at the north and another at the south end, and two similar windows on the east side; while below each window is a steel rolling door extending from the bottom of the window to the ground. By opening all of these, the boiler room can be thrown almost entirely open to air from three directions.

The chimney is 150 feet high and 5 feet inside diameter, of radial brick throughout.

The pumping station is in two levels, the low-lift pumps being on the bottom floor at elevation 25, and the high-lift pumps immediately above on a floor ten feet higher. The upper floor contains three openings, each 40x10 feet, for furnishing to the pump room below, light and air additional to that coming from the boiler room, with which it

connects. The pumping station is furnished with five copper ventilators in the roof in addition to a number of windows.

PURIFICATION PLANT

There are four settling basins in an east and west row, which can be operated either in parallel or in series. The south wall of the basins contains a tier of conduits, each 4 feet wide, and each connected to each basin. The raw water reaches the basins through the upper one, the bottom of which is at elevation 43. Beneath this is a conduit for withdrawing the settled water, with its bottom at elevation 37.17. Below this is a transfer channel, elevation 33.17. At the bottom is a drain for carrying off the sludge from the settling basins.

The bottoms of these basins are constructed with ridges and valleys, each valley containing a line of 6-inch tees, the tee openings pointing upward and each containing a plug with a 1-inch orifice therein. These lines of tees are spaced 38½ inches apart on centers. These are to provide for the continuous removal of the sludge to channels, and thence through iron pipes to the main outlet drain.

For flushing out the basins, a 4-inch cast iron pipe is fastened to the north wall and provided with four 2-inch hose connections in each basin.

At the center of the south wall of the basins are four mixing tanks. In these the chemicals brought in solution from the chemical house are mixed with the raw water by means of propeller blades, two to each tank, attached to the ends of vertical bronze shafts and operating inside of cylinders. The cylinders end a little above the bottom and below the surface of the water, and the water is sucked in at the bottom by the propellers and discharged over the top.

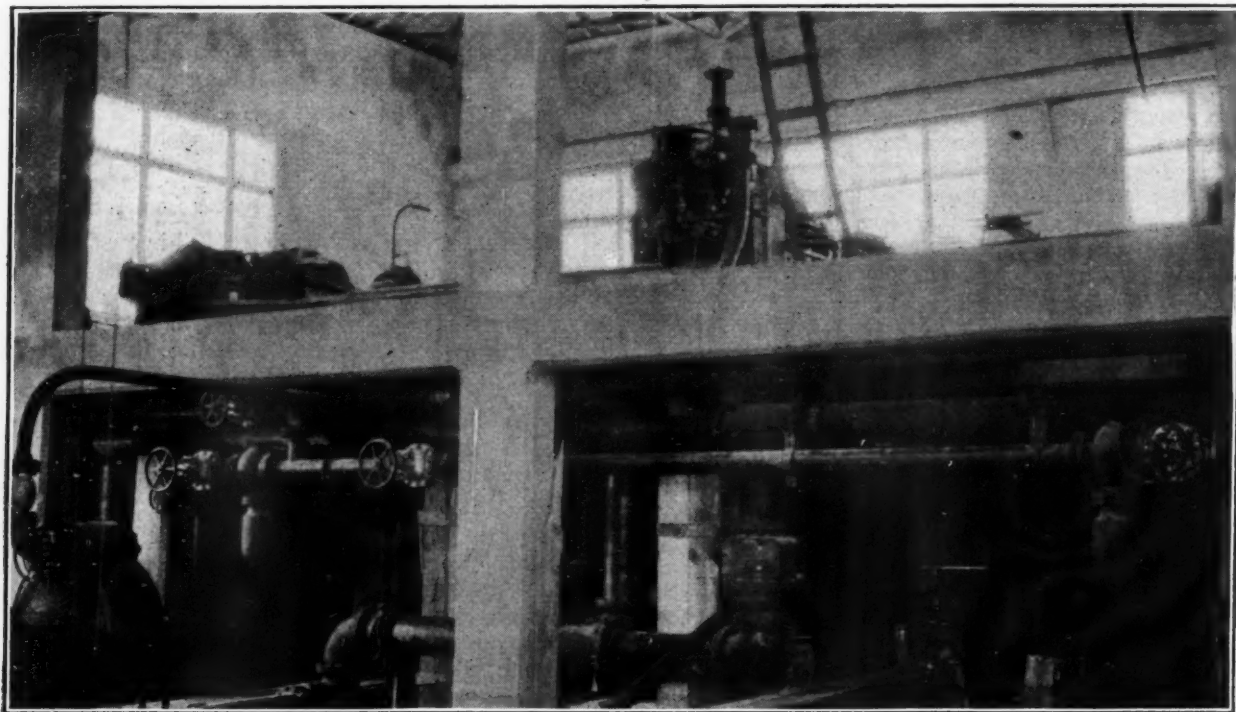
The various chemicals will be brought over the siding, in railroad cars which can be run directly into the chemical house. Here the chemicals will be raised by either bucket conveyor or elevator to

the storage bins in the second floor. From these bins the chemicals will be carried in a steel car of a cubic yard capacity running on a track of 21½ inch gauge, and discharged through a side-discharge chute into any one of six hoppers. Across the top of the car is a screen with ¼-inch mesh which will prevent lumps or foreign matter from passing into the hoppers. These hoppers are of reinforced concrete with walls 7 inches thick and are 8 feet by 12 feet at the top, 12 inches square at the bottom, and 8 feet deep. At the bottom of each hopper is a Gauntt dry-feed machine electrically driven, which can be manually adjusted to feed the dry chemicals at any predetermined rate up to 500 pounds per hour sulphate of iron, sulphate of alumina or soda ash, or 1000 pounds of lime. The connections between the dry feed machines and the bottoms of the hoppers are dust tight.

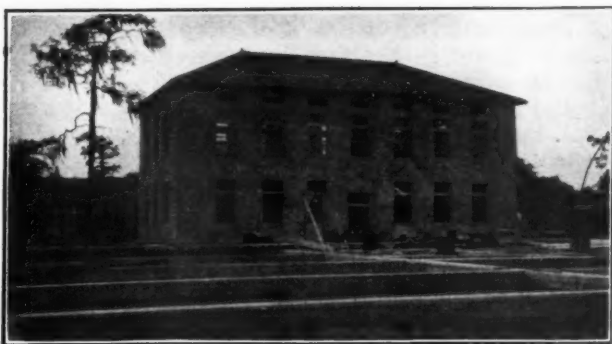
The dry chemicals are discharged into channels in which an abundant supply of water flows and carries them to the mixing and carbonating chambers. The inverts of these channels are lined with half-round tile. The water will be raw water supplied by two water motor driven centrifugal pumps, each with a capacity of 1,000 gallons per minute.

The carbonating apparatus consists of a furnace for combustion of coke or coke and lime, with a capacity from 250 to 1200 pounds per day; a scrubber, and a carbonating chamber. An 8-inch pipe carries the products of combustion to the scrubber, a cylindrical metal tank in which the flue gasses are mixed with water. The gasses from the scrubber are delivered by a compressor through a carbon dioxide meter. The compressor runs at standard speed and the amount of CO₂ delivered at any time is regulated by the admission of air to the gas as it passes from the furnace to the compressor. After passing through the meter, the gas is delivered to a grid in the bottom of the carbonating chamber.

The sulphur dioxide apparatus has a capacity of



UPPER AND LOWER FLOORS OF PUMP ROOM, SHOWING PIPING.



REAR OF CHEMICAL HOUSE, AND SETTLING BASINS

delivering gas generated from the combustion of from 10 pounds to 60 pounds of sulphur per hour. Two Schutte & Koerting sulphur burners are installed in the floor of the retort room. The gas generated is delivered to a spray-absorption chamber, which is on the outside of the retort house but immediately adjacent thereto, through a 6-inch gas exit flue, which is equipped with a water jacket for cooling the gas. Inside the absorption chamber is a lead feeder pipe feeding 15 spray nozzles containing orifices made completely of Dolask metal. The capacity of each nozzle is 60 gallons of water per hour under 40 pounds pressure. The sulphurous acid formed in the absorption chamber is delivered to an 1800-gallon storage tank. From this tank the acid is delivered at the desired rate to the conveying channel which supplies sulphate of alumina from the dry feed machines to the alum mixing tanks.

South of the chemical house, and connected to it, is a filter house. This is constructed with a large central vestibule, at each side of which are four filters, two on each side of a central gallery. The pipe gallery between the pairs of filters is of unusually ample dimensions. It is 10 feet high and 12 feet wide and the piping is so arranged as to give abundant headroom and convenient access to all valves and other parts of the piping systems.

The filters contain $18\frac{3}{4}$ inches of gravel varying in size from $2\frac{1}{2}$ to 2 inches at the bottom to $\frac{1}{8}$ to $\frac{1}{16}$ inch at the top, covered with 30 inches of sand. The strainer system consists of sixty lines of half sections of 6-inch cast iron pipe supported $\frac{1}{2}$ inch above the floor by cast iron spacers, the lines of pipes being spaced 12 inches center to center. There are ten wash water gutters in each filter unit constructed of concrete 15 inches wide and from 13 inches to 16 inches deep at the center.

All gate valves for the control and operation of the filters are hydraulically operated. Rate controllers, wash water controllers, filtered water stage register, wash water stage register and Venturi meters in the raw water line and force main were furnished by the Simplex Valve and Meter Co.

BUILDINGS AND GROUNDS

Considerable thought was given to the appearance of the buildings and grounds. The latter were graded, brick roads and paths laid out, grass and vines planted. The buildings are of hollow tile construction plastered with stucco having a light yellow tint, with glazed tile ornaments over windows and doors, as a frieze etc. The main buildings are roofed with red Spanish tile. The main entrance, that to the lobby of the filter house, has architectural beauty unusual for buildings of this kind.

The main buildings are in two groups. North of the filter house (which faces south) and connected with it is the chemical house; and north of this, underground, are the settling basins and mixing tanks. East of the basins and between them and the river is the other group; first the pumping station facing west, and east of this the boiler room and suction well. The underground filtered water reservoir is between the pumping station and the settling basins.

Some unusual features of design are found in the filter house. Around the outside is a frieze of Faience tiles alternating with bronze grille vents. There are also glazed tile ornaments in the arches over the windows and over the door. The filter house is approached by red brick steps leading to a terrace, around which is a cast stone balustrade. From the terrace one enters the vestibule of the building which occupies the entire depth of the filter house. In the center of the vestibule is a large fountain, while smaller wall fountains are located around the sides. Ornamental columns are placed at the entrance, and also in the galleries for supporting the roof. These columns consist of cast stone shafts, bases and caps.

The filters are located at the right and left of this vestibule, on each side two pairs of filters with an operating gallery between the two pairs; a considerable part of all filters extending beyond the walls of the filter house underground.

The ceiling of the vestibule and also those of the filter galleries, instead of showing steel trusses as is common in filter plants, are in the form of arches; those over the filter galleries



INTERIOR OF FILTER GALLERY, SHOWING ARCHED CEILING.

being circular with a radius of 13 feet, and that over the vestibule being a flat ellipse. These arches are made of plaster on metal lath, the lath being wired to light arched ribs formed of steel angles and channels, and these in turn being suspended from the roof by means of a number of 1/4-inch steel wire hangers. The result of this construction is to provide a most pleasing architectural appearance without involving any unnecessary expense.

From the filter house, a passage leads to the chemical house, the office being located on the right of this passage and the laboratory on the left.

Toilets and wash rooms are provided in the filter house and others in the pumping station, separate ones for whites and blacks. Copper louvres aid in ventilating the chemical storage room and the head house. All building are steam heated. All windows and doors, louvres and other openings are provided with copper screens.

Little trouble was experienced with foundations. Except for the intake chamber, no excavations were carried below ground water level, and all structures rest on solid sand.

The contracts for the various parts of the work were given out as follows: For the buildings and structures, grading the grounds, etc., to the Gauger-Korsmo Construction Co., of Memphis, Tenn. For the filter and chemical equipment, the American Water Softener Co. of Philadelphia, Pa. For the pumping machinery, water tube boilers and interior pipe work, Burford, Hall and Smith of Atlanta, Ga. For laying cast iron water pipe and the waste drain to the river, Benjamin Thompson of Tampa, Fla. For the three steel tanks and towers and also the wash water tank, the Chicago Bridge and Iron Works of Chicago, Ill. The pumping station chimney was built by the Alphons Custodis Construction Co. The cast iron pipe and special castings were furnished by the U. S. Cast Pipe Co.; and the valves, sluice gates, hydrants, etc., by the Iowa Valve Co.

State Highway Specifications

During the past two or three years the Associated General Contractors has endeavored to formulate and secure the general adoption of standard forms for contracts and specifications in various classes of work. It early realized the futility of attempting to standardize the phraseology of state highway specifications, but in 1922 a joint committee of representatives from this society and from the American Association of State Highway Officials approved certain principles covering payment, arbitration, force account and other points which vitally influence economical performance of work.

Many of these principles have been adopted by the various state highway departments, but the adoption has been by no means universal. In the January issue of the organ of the Associated General Contractors is given an analysis of state highway specifications as of October, 1925, with respect to the adoption of these several provisions. The analysis may be summarized as follows:

Negotiable securities are accepted in lieu of surety bond in 8 states, one accepting Liberty bonds only.

Bidder's bond carries a guarantee that surety will bond the bidder if he is given the contract in 4 states; 11 provide for no bid bond.

Definite date is provided for monthly payment in 27 of the 48 states.

Final payment is made within a specified time after final completion in 24 states. Semi-final payment is made when final payment is necessarily delayed in 16 states, while it is optional with the department in 6 others.

Provision is made for acceptance and final payment by sections in 13 states, and 3 others provide for acceptance but not for payment.

Maintenance is terminated upon acceptance of work in 44 states.

Classification of excavation provided varies widely. Eight states provide for earth and rock; 7 for earth, loose rock and solid rock; 5 for common excavation and solid rock; 4 for common, loose rock and solid rock; 2 for common and rock; 2 for earth and ledge; 2 for common, hardpan, loose rock and solid rock; and one of each of the following: Earth, rock and wet; earth, loose rock and rock; common, rock and intermediate; earth, soft rock and hard rock; earth, intermediate and rock. Seven report no classification.

Unavoidable slides and overbreak are paid for by 29 states, and at the option of the department by 4 others.

Compensation is adjusted for delays and suspension due to fault of department in 2 states; for unusual increase or decrease of unit quantities in 23 states, and in 12 others when it exceeds 15, 20 or 25 per cent. No state specification provides for rejection of materials once inspected and accepted. Two adjust compensation for acts of God where department recognizes contractor was not at fault.

The free haul limit used in computing overhaul varies in the different states as follows: 200 ft. in one state, 300 in five, 400 in four, 500 in 15, 1,000 in nine, 1,500 in one and 2,000 in two. Eight make no provision for overhaul and one uses the zone system.

The retained percentage is 10% in 31 states, 15% in 12 states, and 20% in 3 states, while it varies from 7 1/2 to 15% in Oregon and from 10 to 15% in Washington. The percentage retained is reduced as the work progresses only in Kansas, and in Maine at the option of the department.

In force account payments, the percentage paid on labor is 10% in 16 states, 15% in 26 states, and nothing in 1 state; while the amount paid on material is 5% in 1 state, 10% in 15 states, 15% in 16 states and nothing in 12 states. In 2 states, the percentage is subject to agreement, in 1 there is no provision, and in another the amount is stated in the bid.

The percentage paid monthly on materials delivered is 50 in one state, 60 in one, 65 in one, 75 in four, 80 in three, 85 in four and 90 in four; while twenty-four make no such payments and in four it is optional with the department.

In only three states is arbitration provided for.

Asphalt Concrete in California

Asphaltic concrete is used principally in reconstruction work on California highways, and its use, in suitable locations, provides an economical means of utilizing the supporting strength of the old pavement. The design of the cross section is worked out in each case to best meet local conditions. In some places, the old pavement has been widened by adding $2\frac{1}{2}$ feet of cement concrete on each side and an asphaltic concrete surface is laid over old base and the new concrete. A more usual practice is to construct new concrete shoulders $2\frac{1}{3}$ feet to 8 feet in width along one or both sides of the old pavement at a grade of two to four inches above the old surface. Asphaltic concrete is then laid between the new shoulders, utilizing the old pavement as base.

Where soil conditions are favorable, the old fifteen-foot pavement has been reconstructed and widened to twenty feet by constructing $2\frac{1}{2}$ feet of asphaltic concrete base on the sides of the old pavement and then by surfacing the full twenty feet of width with an asphaltic concrete wearing surface. So far, there has been no evidence of any tendency for separation along the joint between the old concrete and new asphaltic base.

An effort is being made to improve the design of asphaltic concrete mixtures to prevent corrugating and displacement under traffic. A reduction in the amount of asphalt used for heavy traffic pavements, below the amount considered necessary ten years ago, has been found highly desirable. The penetration of the asphalt has been reduced to 50° or lower. In the average surface mixture, the asphaltic cement used is generally about 5 per cent to 5.5 per cent or slightly higher. Coincident with a decreased asphalt content it has been found feasible to increase the amount of very fine stone dust in the mixture apparently with beneficial results.

Experiments have demonstrated that the slipperiness of asphaltic concrete pavements is reduced by the omission of the flush coat and this has been omitted on asphalt pavements laid during the last two seasons.

North Dakota Highway Construction Limited By Finances

The North Dakota State Highway Department in December stated, in a public announcement, that it had reached the peak of its road construction and could not exceed its present rate unless the state increased its appropriations and changed its plans. At present, all of the work done is that receiving federal aid and is limited by the amount of such aid allotted. Consequently, the department's rate of expenditure cannot be increased unless the state appropriates funds for work to be paid for entirely by the state, with or without aid from the counties or communities.

The average cost of road work to date has been about \$4,000 a mile for grading and \$2,500 for gravel surface. A little hard surfacing has been done at a cost of about \$36,000. It is believed that the state must come to hard surface roads sooner than most of its citizens imagine, which will greatly reduce the mileage of roads that can be improved. It is suggested that the time has arrived when those

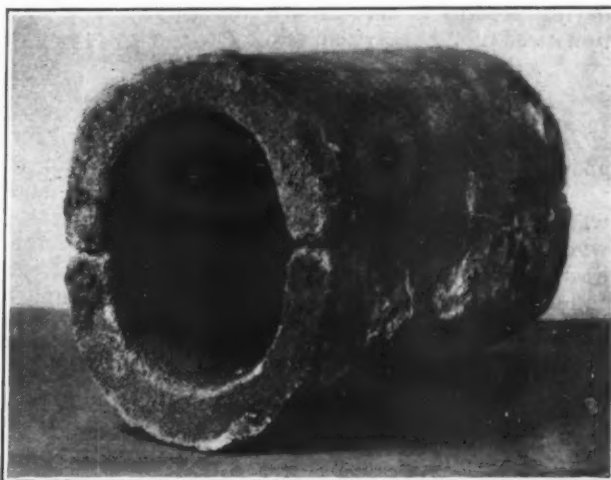
interested in the state highways should get together and endeavor to formulate and put across some plan for securing larger funds for constructing and maintaining roads throughout the state.

Concrete Sewer 58 Years Old

By Edward S. Rankin*

While installing the necessary underground work in preparation for repaving one of the oldest streets in Newark, N.J., a line of concrete pipe was uncovered, one section of which is shown in the accompanying photograph.

As clearly shown in the cut, the concrete was moulded in two equal parts. When laid one on top of the other these formed a pipe 18 inches in length with an elliptical bore 7 inches vertical by $5\frac{1}{2}$ inches horizontal diameter.



CONCRETE HOUSE CONNECTION 58 YEARS OLD.

The pipe was used as a sewer connection from a private house to the main sewer in the street and the records show that the connection was made in 1867. The concrete after 58 years of service showed no signs of disintegration.

A Sludge Digestion Experiment

Wm. Gore and Geo. G. Nasmith, consulting engineers of Toronto, described in the "Canadian Engineer" investigations in treating Toronto sewage, using a tank divided into three compartments, the first for digestion, the second for aeration, and the third for final settlement. The first compartment, which received settled sewage, was seeded with ripe digested sludge from Imhoff tanks and the effluent was passed into the second chamber, where air was applied through filtros plates. The sludge settling in the final compartment was returned to the aeration chamber, and the excess activated sludge from this was discharged into the digestion tank. Apart from variations due to mechanical imperfections in the apparatus employed, the purification effected was high. The sludge from the digestion chamber was black and granular and had a slightly tarry odor, corresponded fairly closely with best Imhoff tank sludge, and dried readily.

*Engineer in charge, Bureau of Sewers, Newark, N. J.

A new feature of particular interest was the production of a sludge which had the characteristics of both activated and also of digesting sludge which, unlike activated sludge, will decompose without offense if allowed to stand under anaerobic conditions. Presumably it was formed by particles of digesting sludge being carried over into the activated sludge chamber and there built up into particles of activated sludge. The authors suggested that this new feature can be applied to existing activated sludge plants by bringing the raw sewage into contact with digesting sludge or by adding, more or less continuously, a small quantity of ripened digested sludge to the activated sludge in circulation. The excess sludge will then, if allowed to stand, digest without offense, yielding a sludge with the inoffensive characteristic tarry odor of good Imhoff sludge with its good drying qualities. If conversion of sludge to fertilizer by drying process is desired, the full period of digestion need not be carried out.

Combined Sidewalk and Sewer

About three hundred years ago a plantation for growing indigo and sugar cane existed at what is now the city of New Smyrna, Florida. The land was swampy, and to drain it a canal was dug eastward to the Indian river. The town of New Smyrna developed at one point on this canal, the main street following along one side of the canal, which occupied the space that would ordinarily be devoted to a sidewalk, the residences across the canal being reached by plank bridges spanning it in front of the houses.

This, of course, had its inconveniences and it had been suggested from time to time, for a number of years, that this condition should be remedied. One obstruction to the improvement was local pride in the canal as an old historic landmark. However, this sentiment was at length overcome, and the city council decided to wall in the canal and build a sidewalk over it.

This work has now been completed. The bottom of the canal had been excavated in the soft coquina rock which underlies that section, so that an artificial bottom was not necessary. Side walls of concrete 12 inches thick and averaging about 4 feet high were built. A slab of reinforced concrete spans the space between these walls and serves as a sidewalk. The value of property on that side of the street has increased two or three fold since the sidewalk replaced the open canal.

English Refuse Salvaging

Fifteen to twenty-five years ago, it was quite generally stated and believed that the English engineers had solved the refuse disposal problem by their high temperature destructors, one of the great advantages of which was that the heat generated could be utilized and the cost of destruction be more than recovered thereby.

During the past few years, reports have come from England that destructors have proved to be money makers in few if in any cases, and that many cities have turned to salvaging as promising to furnish more financial advantage and being reasonably satisfactory from a sanitary point of view.

However, some English cities are already finding

that the elaborate salvage plants which they have constructed are not proving as financially satisfactory as had been expected. A recent report of the city comptroller of Westminster for the latest fiscal year shows that the expenditure for the city's refuse plant for that year exceeded the income by nearly \$20,000, the amount of refuse treated having been 11,074 tons and the cost about \$3.65 per ton.

The failure of the plant to come up to expectations financially is attributed to three causes: 1—Inability to operate the plant at its full rated capacity, largely owing to lack of duplication of parts. 2—Inability to separate certain vegetable matters from cinders, thus rendering the latter unsalable. 3—Cost of removing the pulverized residue, which was about 80 cents a ton. At the time plans for this plant were being drawn up, some of this material was being sold in London for about 45 cents a ton, but the demand seems to have disappeared.

Tar Treatment of Gravel Roads

Method evolved by Wisconsin Highway Commission after trying the Maine method

In common with other states, Wisconsin finds one of the most important problems for its highway commission to be that of developing a large mileage of comparatively low-type road that will meet the demands of traffic within limits of the rather small funds available for the purpose. Several roads are called upon to carry a large amount of interstate as well as state traffic which can not be served adequately by gravel roads, which are the only kind within the present means of the counties in which they lie. Experience in many states has shown that when traffic reaches 500 or more vehicles per day, the maintenance of a gravel road becomes impracticable or uneconomical. It is found that such traffic causes a loss of material from the gravel surface of 400 to 600 cubic yards per mile, the cost of replacing which would be about \$800 to \$1,200. In addition, this material, when leaving the road, causes a serious dust nuisance.

Endeavoring to meet this problem, the Wisconsin Highway Commission in 1922 followed the Maine method of treatment, scarifying the gravel road to a depth sufficient to remove all lumps and depressions, immediately after which a large-blade grader was used to shape up the road to a uniform cross section, which shaping up was continued while traffic used the road and compacted it. The surface was then swept with a power sweeper and a priming coat of light tar was applied at the rate of about 1/6 gallon per square yard; after 48 hours, additional treatment by hand being given to such spots as needed it. A second application of tar at the rate of 1/3 gallon per square yard was then applied, immediately followed by a blotter of course torpedo sand.

Twenty miles treated by this method in 1922, 60 miles in 1923 and 200 miles in 1924 were on the whole successful, but it was found that the roads

required fresh treatment each year. In 1923 a new method was tried as follows: A road was treated that had been surfaced with material which contained a considerable amount of coarse gravel which it was impracticable to clean by sweeping. The road was shaped to a uniform cross section with a large-blade grader, and tar was applied at the rate of about $1/3$ gallon per square yard, traffic being allowed to use the road freely to mix the tar with the gravel. After about two hours, the blade grader outfit, with the blade set at an angle of 45 degrees and a depth of $3/4$ inch, was run over the surface, moving the material a few feet past the center of the road. A second application of about $1/3$ gallon was applied and the winrow at the center was then moved back over the newly applied tar. The same process was then followed on the other half of the road. This method gave a penetration of between 1 and $1\frac{1}{2}$ inches. A mile of road treated in this way in 1923 required practically no maintenance that year, and only a few patches along the shoulders in 1924, costing less than \$100 a mile; and it is believed that it will not be necessary to scarify sections treated this way, but that a light application of tar with an absorbent every second year will keep the surface in very good condition.

In 1924 the commission used the same treatment on 12 miles of the Middleton-Souk City road, which is one of the heaviest tourist roads, the traffic counts averaging between 2,500 and 3,000 vehicles a day during the summer months. The surface of this road is 21 feet wide. The treatment of the 12 miles was completed in 14 days, although it rained on three or four of the 14. The cost of this treatment was \$1,287 a mile, which includes 110,000 gallons of tar at 12.95 cents a gallon, labor at \$33 a day and rental, operation and depreciation of equipment (including the rainy days) at \$53 a day.

Such tar treatment of course does not take the place of a durable pavement, but it does conserve the material, lay the dust, and provide an adequate surface until such time as funds are provided to build durable pavements.

Marl-Sand Roads in Minnesota

The University of Minnesota Engineering Experiment Station and the Minnesota State Highway Department have co-operated in experimenting with the use of marl for producing good roads for moderate traffic in the sandy areas of the state. About three years ago, the experiment station began experimenting by means of an appropriation provided by the state legislature, Prof. F. C. Lang having general supervision of the investigation and Charles H. Dow conducting the laboratory experiments and supervising the construction.

In the northern lake region of Minnesota there are known to be very good deposits of marl, and still others have been found since the use of the material for building roads was found to be desirable. Marl is a soft earthy material, composed principally of an amorphous form of carbonate of lime. As excavated around the lakes, it is usually wet or at least damp.

In building the test road, this was divided into sections about 200 feet long, and improving was done one section at a time. It was found by trial

that it was necessary to mix the sand and marl to a depth of at least six or seven inches, using four inches of marl with six of sand or five inches of marl with seven inches of sand. A thinner crust than this apparently cuts through too readily.

The marl is mixed with the sand by means of a disc harrow, assisted by traffic going over it. Following the mixing, a drag or planer is run over the road a few times at intervals of several days to iron out the ruts. After once being gotten in shape, few ruts form and very little dust. In dry weather, however, some dust and deterioration may be noticed, and the use of calcium chloride or the application of a gravel blanket are effective in preventing further action of this kind.

Park System of Westchester, County, N. Y.

The Bronx River Parkway, extending from New York City to Kensico Dam in Westchester County, (see Public Works for October 2, 1920 and December, 1925) had been so generally recognized as a success even before it was completed that many citizens of Westchester County became enthusiastic advocates of an extensive system of parks and parkways throughout the county. Through their initiative, the state legislature in 1922 adopted a law providing for the organization of a Westchester County Park Commission. Such commission was organized in 1923 and has continued to function with increasing activity, although little actual construction work was done until 1925.

The first essential of developing a system of parks was, of course, the acquisition of the necessary lands, following a decision as to what lands were necessary or desirable for the purpose. The commission has recommended and the County Board of Supervisors has authorized parks and parkways totaling 10,815 acres in area, the estimated cost of acquiring which is about seventeen million dollars. The area includes the 1,100 acres of Mohansic Park which was conveyed by the state to Westchester County for \$1. In addition to this cost, millions will, of course, be required for developing the parks and parkways. In addition to the area named, that portion of the Bronx Parkway lying in Westchester Co. has been turned over to the Westchester County Park Commission, the Bronx Parkway Commission having ceased to exist on December 31st, 1925, as it had completed the work of constructing that parkway. Also, one million of fifteen million dollars voted by the state for state park and parkway projects is to be expended by the Westchester County Park Commission as agent for the state in extending the Bronx Parkway from Kensico Dam to the Bear Mountain bridge.

The new Westchester County Park System will include 9 miles of waterfront on the Hudson river and Long Island Sound, and numerous lakes, both natural and artificial. This will provide extensive facilities for bathing, boating, and skating. There will also be baseball and other athletic fields, tennis courts, golf courses and recreation grounds, picnicking and camping places, forest reservations, and

motor traffic parkways to make the various parks accessible to each other and to all parts of the county.

The parkway system has been laid out to provide a skeleton plan for the county's future growth. Most of the parkways will serve to relieve the intense traffic, so far as pleasure vehicles are concerned, that now crowds the north and south traffic routes through the county and also provide, to a certain extent, for the limited amount of east and west traffic.

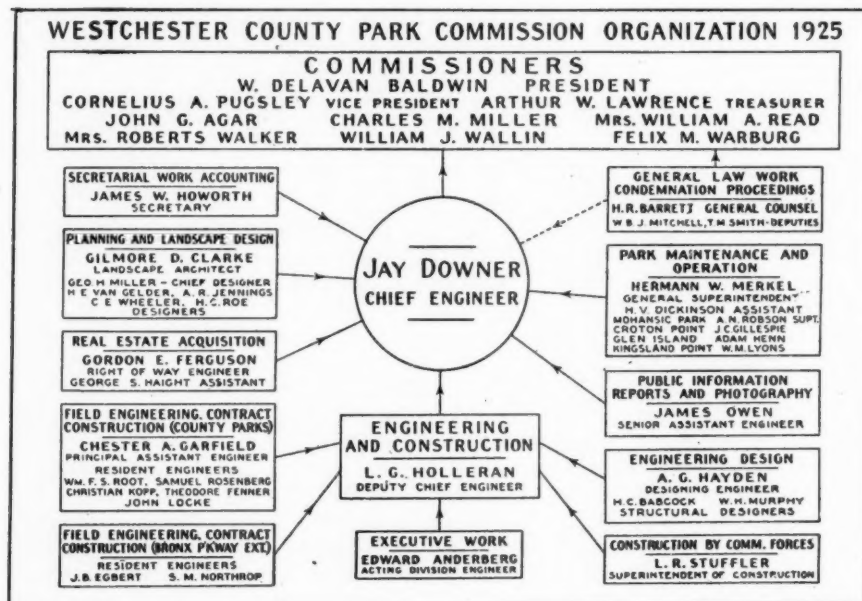
In acquiring lands for the parks and parkways, the county's policy has been to obtain them by negotiation and direct purchase from the owners where possible, condemnation proceedings having been resorted to in very few cases, although nearly 300 parcels have been acquired. The method followed has been first to secure options on large parcels, generally in a single ownership, forming a nucleus of the proposed park or reservation, and leave the smaller desirable, but not absolutely essential, subsidiary parcels subject to subsequent negotiations on account of the large amount of detail involved.

and comfort stations have been provided for picnickers. Work completed or started during the year 1925 will reach a cost estimated at \$3,381,000.

Most of the parkways follow the courses of streams and it was foreseen that, if these streams were not to be polluted by sewage, it would ultimately be necessary, or at least desirable, to remove the sewage from many small communities by intercepting sewers paralleling such streams. It is apparent that both convenience and economy to such communities might be served by the commission should it provide in its plans for the future location of such intercepting sewers in the parkways themselves. With this in mind, the state legislature in 1925 created a commission to prepare and report preliminary plans for sanitary trunk sewers and outlet sewers in Westchester County, providing that the members of this commission consist of the members of the Westchester County Park Commission. This legislation was due largely to the request of the villages of Hasting, Dobbs Ferry, Ardsley and Elmsford in Saw Mill River valley, with a view

to having a trunk sewer built through the valley to serve those villages.

There has been the closest co-operation between the Bronx Parkway Commission and the Westchester County Commission; in fact, many of the officers of one commission occupied similar positions on the other, this applying especially to the engineering staffs. Jay Downer was chief engineer of both, and L. G. Holleran, deputy chief engineer. In general, the engineering, landscape design, and construction staffs of the new organization were recruited from that of the Bronx Parkway Commission. The organization is shown on the accompanying diagram.



ORGANIZATION DIAGRAM, WESTCHESTER COUNTY PARK COMMISSION.

Appraisals of the property are made by men selected because of long experience with property values in Westchester County; and the appraised price, the owner's asking price and the judgments formed by personal examination by members of the park commission, are used as the basis of agreement with the owner.

In addition to acquiring land, about forty construction contracts have been let for clearing, grubbing, and grading and constructing bridges. A hill along the Hudson has been leveled, and the material used for widening a road leading to it along the edge of a marsh. Two dredges have been at work forming an 80-acre salt water lake at Manursing Island Park, and considerable work has been done in preparing an 18-hole golf course at Mohansic Park. At Glen Island, old buildings have been removed and debris cleared away, and similar work has been done at a number of other points where land has been acquired. At Woodlands Park, fire places, benches

Effort has been made to fill the positions as far as possible from residents of Westchester county; but although engineering vacancies ranging from assistants at \$1,320 a year to division engineers at \$6,000 a year were widely advertised in the county newspapers and engineering journals, it has not been possible to obtain a sufficient number of applicants from the county.

As already stated, comparatively little construction work has yet been done, although 40 or more contracts have been awarded, the largest of which was the dredging in Manursing Island Park (already referred to) the amount of this contract being \$336,000, which was awarded to the lowest bidder, the Trimount Dredging Co., of Boston, which uses a ten-inch and a twelve-inch suction dredge for an amount of dredging and filling estimated at 800,000 cubic yards. The next largest contract was for grading a section of the Saw Mill River Parkway, Yonkers, the amount of the contract being \$207,275.

Contrivance to Facilitate Multiplication

A Simple Scheme for Performing Calculations Accurately and Rapidly Where the Same Number is to Be Multiplied Several Times

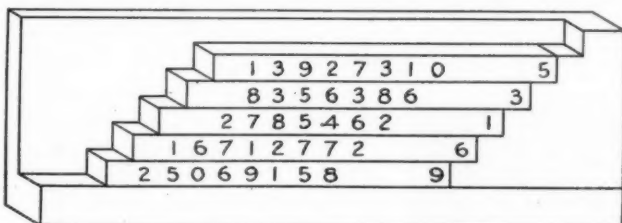
By Francis E. Daniels*

In the absence of a calculating machine, and especially if one has access to an adding machine, the following scheme will enable one to compute tables requiring the multiplication of large numbers or decimals by the same number. The work is done accurately, quickly, and in a manner easily checked.

For example, the number 2,785,462 is to be multiplied many times. It is multiplied by 1, 2, 3, etc. up to 9 and these products are typewritten on narrow strips of paper and pasted on the edges of blocks of wood so that each right hand figure is exactly the same distance from the right hand end of its block.

A block to be held in the left hand is made of a piece of board with a strip along the lower side and a notched stop on the right end as shown. The height of each step is the same as the thickness of the number blocks, and the distance to the right in each case equals the distance between the centers of the typed figures. This will give straight vertical columns when the blocks are all pushed to the right as far as they will go.

To multiply, take in succession the blocks indicated



MULTIPLYING 2,785,462 by 96,135.

by the digits of the multiplier and drop them in place and push them to the right, and you will have the number multiplied.

The illustration shows 2,785,462x96,135. Now add these on the adding machine and you will have the correct product. If a large part is a decimal have a hinged paper flap to drop over such decimals as are not desired and add up the figures on the left.

If there are likely to be several figures alike in the multiplier, then a sufficient number of sets of blocks can be used. The blocks can be made easily or such blocks as dominoes or sections cut from a ruler or yardstick are suggested. If a zero occurs, just turn over a block for a blank in the proper place.

If, as sometimes happens, a number is to be added or subtracted from the products, then some blocks may be made whose number is greater or less by this amount and so noted. This will enable the multiplication and the other operations to be done at the same time.

For example, the writer has just computed a long

*Chemical Engineer, Pennsylvania Department of Health.

table involving the multiplication of a number with 7 figures by specific gravity figures with 5 decimals, and from the product in each case a 5 decimal number was subtracted.

Three sets of blocks were ample and as all the gravities began with a 9, one block was made with a number less than the 9 product by the number to be subtracted. This was marked 9-A and always kept in the bottom line.

Incidentally, this table is extremely useful in reading the percentage of alcohol in a sample analyzed directly from the weight of the distillate in the pycnometer, thus avoiding long calculations in each case.

One can readily see how such a scheme may be adapted to many other calculations, and the lessening of the chances for error and the rapidity with which the work is done and checked amply repays one for the little trouble in preparation.

Developments in Electric Street Lighting During the Year 1925*

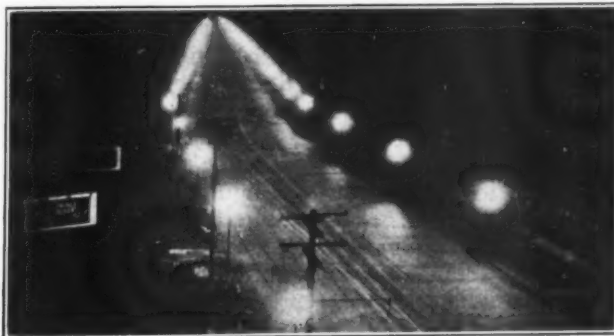
The continued popularity of adequate street lighting was demonstrated by the sale of equipment for this purpose increasing approximately 40 per cent over the figures for 1924, which in turn was a record year.

As an indication of the high illuminating intensities which are now considered as desirable for street lighting, the city of Cleveland, O., provided Superior Avenue with 25,000-lumen lamps, this being the highest intensity street lighting installation. The previous maximum was 15,000 lumens.

What is probably the most unique street-lighting system of the year was installed in Chinatown, San Francisco, and consists of a standard designed in imitation of a bamboo stalk which is surmounted by a lantern of pagoda design glassed with amber panels. In these standards, 15,000-lumen lamps are used, and the oriental effect is heightened by the addition of golden dragons encircling the shaft and a liberal use of color in the other decorations.

The use of two-light standards on main streets

*From a general review entitled "Some Developments in the Electrical Industry During 1925," by John Liston, of the General Electric Company.



SUPERIOR AVENUE, CLEVELAND, OHIO.

of cities is becoming more widespread. The following cities during 1925 used this method for carrying out their program for the intensive lighting of their white-way districts:

Cape Horn, South America
Dunham, N. C.
Glendale, Calif.
Havana, Cuba
Indianapolis, Ind.
Lakeland, Fla.
Margate City, N. J.
Portland, Ore.
Richmond, Va.

Santa Ana, Calif.
San Diego, Calif.
Santiago, Chili.
Sarasota, Fla.
Turlock, Calif.
Vina Del Mar, Chili
Washington, D. C.
Wilson, N. C.

An installation in Lynn, Massachusetts, when completed, will be in reality a street-lighting exhibit on a large scale. There will be about two miles of each of 15 different kinds of street-lighting equipment, ranging all the way from arc lights on double-light standards in the heart of the business district to highway lighting units on the outskirts.

The National Electric Light Association appointed a special street-lighting committee to investigate and submit a report at the San Francisco Convention. This report set forth in detail the value of the street-lighting load to the central station, provided it is sold upon its merits to the city at a price which would bring a fair return to the lighting company.

In order to assist in bringing this important subject to the members who hold executive positions with their respective companies, a unique method of demonstrating street lighting was made available at the convention, consisting of a model street built in miniature. The street itself was a reproduction of a block 400 ft. long, showing the types of buildings, etc., usually found on the main street of a large city.

The model was built on a scale of $\frac{3}{8}$ in. to the foot, and all details were accurately reproduced.



MODEL OF A LIGHTED STREET ON A SCALE OF $\frac{3}{8}$ in.-1 ft.

Duplicate sets of lighting standards, viz., single-light ornamental standards and three-light ornamental standards, were located on the street. These were so equipped electrically that sizes of lamps from 250 to 2,500 c.p. could be shown, thereby making it possible to demonstrate the lighting effects produced with various spacings and sizes of lamps. As was the case with the other sections of the model, the lighting standards and the light output of the lamps themselves were reproduced accurately to scale.

In order to give the appearance of a complete street, the store windows were trimmed and illuminated, the lighting effects being both in clear and colored light. Stationary and flashing signs were installed, roof signs illuminated, and, in fact, every detail that would be encountered on an actual street was represented. At the far end of the street was located what might be termed a municipal building, for which provision was made to show the effect of floodlighting both with clear light and color.

The use of automatically controlled signal lamps for directing traffic at important street intersections is becoming common in many cities. These lamps have a definite time cycle of operation and are controlled by an automatic time-control switch or timer which consists of a variable-speed induction-disk motor driving a cam-operated switch mechanism for controlling the red, amber, and green traffic lamps.

In order to provide flexibility for handling different conditions of traffic, the timer is equipped with two adjusting dials by means of which its timing cycle may be altered. The left-hand dial controls the time for each complete cycle of operation, and the right-hand dial controls the division of right-of-way time between two streets. By proper adjustment of both dials, any desired time cycle can be obtained.

For certain conditions, the timer is also furnished with a disk-type synchronous motor instead of the induction-disk motor, where it is necessary to operate a number of individual timers in step with each other.

Among the more important highways provided with the double nested reflector type of highway lighting unit during the year were the Hylan Boulevard on Staten Island, fifteen miles in length, and a five-mile stretch at Atlantic City. A new type of highway lighting unit, utilizing a glass refractor, was installed for a distance of $2\frac{1}{4}$ miles at Cadillac, Michigan.

The outstanding demonstrations of spectacular illumination were the displays at Seattle during the Knights Templar Conclave and at San Francisco for California's Diamond Jubilee. In Seattle the treatment of the streets varied, and combinations of illuminated banners, flame-typed globes, and colored lamp festoons were used.

At San Francisco there was the greatest temporary lighting display ever staged. The features were "El Arco de Brillantes," using 40,000 glass jewels; the illumination of the City Hall and other buildings of the Civic Center; radio controlled panchromatic electric fountains; and the lighting of Market Street by 20,000 colored Mazda lamps festooned with evergreens as decorations to the existing triple-arc lighting standards. Fifty searchlights and many hundreds of floodlights were used in the Scintillator and Civic Center illumination.

Large Street Lighting Contract

What is believed to be the largest contract for street lighting equipment ever placed has been awarded by the city of St. Louis to the Westinghouse Electric & Mfg. Co. for a new street lighting system. The contract calls for 10,000 standard light units, reflectors, and auxiliary equipment. A plant will be erected in St. Louis for delivering hollow spun concrete posts at the rate of 1000 a month, as required by the contract.

Cement Plant For Florida

The Lehigh Portland Cement Company of Allentown, Pa. is preparing to build in Florida the first plant in that state for manufacturing Portland

cement. It has acquired approximately 1,275 acres in the vicinity of Ocala in the heart of the limestone region.

The company has had a mill in Florida under consideration for some time, and believes that, with the limestone on the property which it has purchased, it can manufacture cement equalling the quality of that produced by its twenty other mills. Construction of the plant is being hastened because of the freight congestion which has made it difficult to ship cement and other building materials into the state. The company hopes to begin shipping cement from this plant by early next fall. One of the difficulties of the enterprise is the fact that Florida produces no natural fuels.

Water Supplies for Northern N. J.

Report on the possibilities and costs of supplying this section for the next fifty years, with recommendation by the North Jersey District Water Supply Commission that a distributing reservoir be built at Chimney Rock.

We have published several articles describing the construction of the Wanaque dam and reservoir for supplying water to a number of communities in Northern New Jersey, most of which serve as suburbs of New York City and of Newark. The communities to be so supplied are Newark, Paterson, Passaic, Clifton, Glenridge, Montclair and Bloomfield, with possibly one or two other small towns. It is expected that these communities will be receiving water from this supply in 1927.

There will, however, hardly be breathing time allowed before it will be necessary to begin work on an additional supply; for the North Jersey District Water Supply Commission has estimated that an amount equal to that of the Wanaque project will have to be added to the available supply about once every eight years if the population and water needs of that section of the state continue to increase at the rate at present indicated.

The commission has studied the water situation and requirements with a broad view to the future. They have considered a number of projects proposed by others, including the Stony Brook project proposed by Weston E. Fuller for the city of Elizabeth, and the Long Hill project recommended by Allen Hazen, a synopsis of whose report was given in PUBLIC WORKS for April 1st and 8th, 1922. What they propose is that known as the Chimney Rock project, the first step of which would be provision for furnishing a supply of about 150 m.g.d. at a cost which is estimated at \$305,000 per million gallons per day. (The estimated cost of the Wanaque water is \$204,000 per million gallons per day.) Ultimately the project could be extended to supply 750 m. g. d. The existing water supplies of this northern section of New Jersey have a combined capacity of about 266 m. g. d., so that the proposed Chimney Rock project would ultimately furnish nearly three times the present consumption. The maximum increase in consumption rate was between the years 1914 and 1920, when the water consumption in this district increased from 189 m. g. d to 245 m. g. d.

What is known as the "six counties," which com-

prise the northern part of the state containing the densest population, had in 1920 a combined population of 2,062,000. The population in 1970 was estimated by Hazen in his report to be 5,600,000; and by the North Jersey Commission to be 5,350,000 estimating by one method and 7,360,000 by another method. The commission uses the average of these three, or 6 million, as the probable population in 1970. The water consumption per capita of these six counties increased from 73 in 1890 to 118 in 1918, '19 and '20, and had fallen to 110 in 1924. In studying the problem, the Commission assumed that the per capita consumption would increase at the rate of about 0.8 percent per year and reach 146 gallons in 1970. This would give a water requirement in that year of 870 million gallons per day.

AVAILABLE WATER RESOURCES

Quoting from a report of the commission which has just been made public: "The Six Counties are peculiarly situated in relation to available sources of water supply. Probably nowhere in the world is there so large and rapidly growing a population with such enormous supplies of water of good quality practically at their door and, in addition, many of the sources with excellent reservoir sites at sufficient elevation to deliver by gravity. . . . With the naturally favorable location of demand and supply, it will be possible to develop an almost ideal system of water supply for the whole district if the problem is approached in a broad way along well considered lines.

"Excluding in every case the area of the Six Counties, the entire Passaic, Wallkill, Raritan and Delaware watersheds lying within the state can be made sources of water supply for the Six Counties. All this can be accomplished by main aqueduct lines less than 60 miles in length and by pumping under pressure head of less than 200 feet."

The report discusses at some length the watersheds of the Hackensack, Saddle, Ramapo, Wanaque, Pepuannock, Rockaway, Upper Passaic, Elizabeth, Rahway, Millstone, Musconetcong, Pohatcong,

Pequest and Delaware rivers, and Green, Stony, Middle, Beaver and Flat Brooks, the northern and southern branches of the Raritan, and Paulins Kill. In studying the yield of these various sheds, the commission made certain fundamental assumptions, among them that a fair average yield would be 1 million gallons per day per square mile if ample storage capacity be provided; that if diversion works with a maximum capacity of about 3.3 million gallons per day per square mile be constructed, 0.8 million gallons per day per square mile could be obtained when equalized in a distribution reservoir; and that pumping plants having a maximum capacity of about 2.3 million gallons per day per square mile would furnish at least 0.5 million gallons per day per square mile when equalized in a distribution reservoir.

The estimated total capacity of all of these water sheds is 2,581 million gallons per day, of which 1,434 million would have to be pumped.

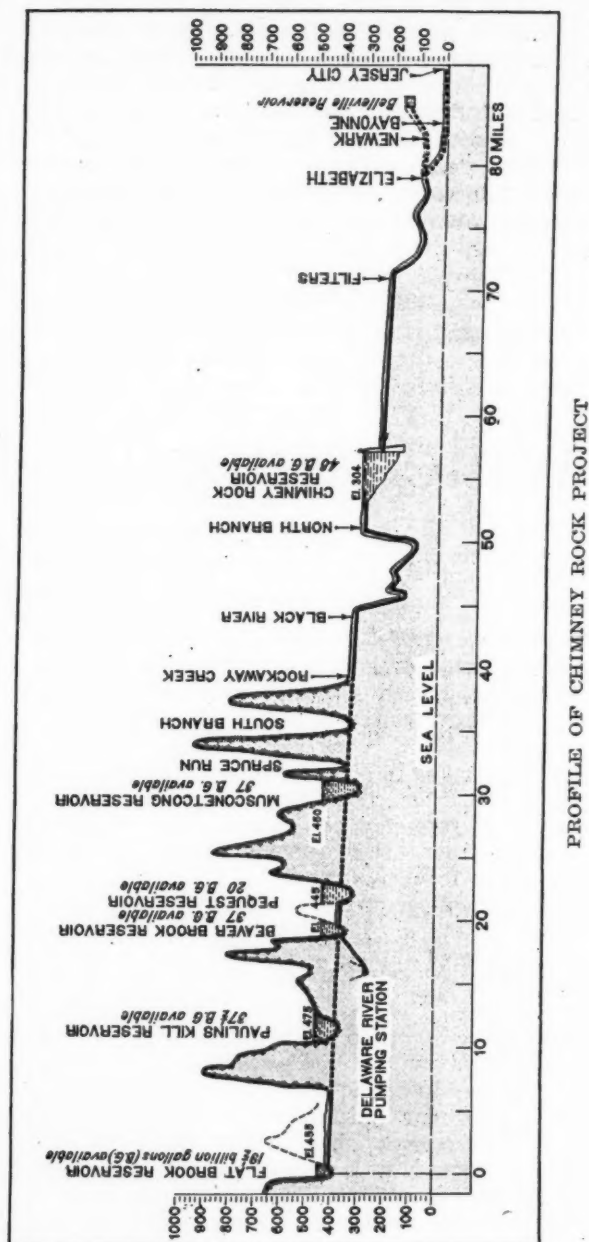
It would, of course, be unwise to spend money immediately for a total development that would not be required for many years to come, and a program was outlined by which it will be possible to choose the best supplies for early development, leaving the less desirable for consideration in the future when the demands more nearly reach the limit of available resources.

While the total available yield is considerably more than will be necessary for 50 years to come, it will provide for all only if the communities in this section of the state unite for the development and equitable distribution of the available resources. Moreover, should each community individually go into the mountainous territory to the west and bring its supply through a conduit, there would ultimately be a score or more of conduits crossing a considerable part of the state, the combined cost of which would greatly exceed the cost of two or three conduits built jointly for and by all the communities concerned.

The natural drainage lines in the northern end of the state are such as to divide the area into three sections, one highland section draining toward the north or the northern end of the Six Counties; another draining toward the south or southwest; and a low-land section almost completely surrounding the other two sections, all the water from which must be pumped to be made available for use. At present all of the aqueducts for this district bring supplies from the north, while the most acute shortage of water at present is in the southern part. Therefore, it was concluded that the next development should be in the southwest group of water sheds.

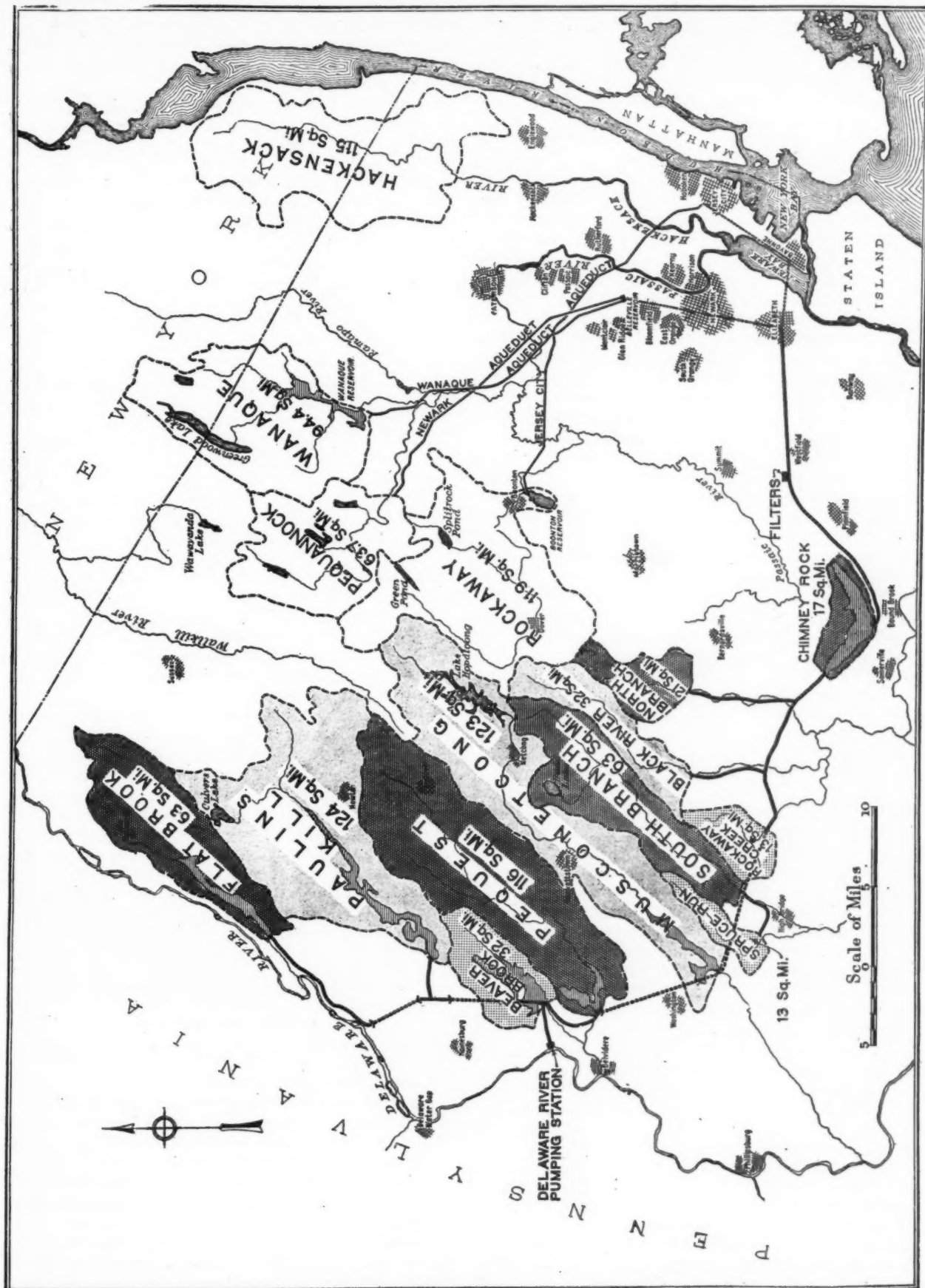
Almost all of the streams in the southern group tend to flow away from the Six Counties, as a result of which, storage reservoirs within the watersheds would be at considerable distances from the centers of population. Consequently, the utilization of these supplies would seem to demand a large storage and distribution reservoir located as near as possible to the Six Counties. Several sites for a large reservoir were studied by the commission, especially those known as Long Hill and Stony Brook.

As already stated, the commission, after studying various proposed projects, came to the conclusion that unquestionably that known as the Chimney Rock



project was the most desirable. Before reaching this conclusion, a field reconnaissance of the proposed reservoir sites was made, consideration being given to foundation conditions at dams, location of spillway channels, highways and railways affected, population and water power plants which would be dispossessed, all of which have a bearing on the probable cost of development. Surveys and topographic maps were made of all the more important dam sites. The quality of the water was studied, involving the establishing of about 77 sampling stations and the analysing of over 1,450 samples.

The considerations which determined their selection of the Chimney Rock project were as follows: "Located in the valleys of the East and West Branches of Middle Brook, directly north of Bound Brook and Somerville and almost entirely surrounded by the First and Second Watchung Mountains, lies one of the finest natural sites for a large storage reservoir that can be found in the state. This



PLAN OF CHIMNEY ROCK PROJECT, SHOWING LOCATION OF WATERSHEDS AND APPROXIMATE LOCATIONS OF RESERVOIRS AND AQUEDUCTS.

Chimney Rock Reservoir site (so called because the main dam would close the gap in the First Watchung Mountain at Chimney Rock) has practically all the natural advantages that have come to be associated with first class water supply reservoirs. It is deep with fairly steep side slopes, it has no shallow flowage areas, it is almost entirely surrounded by hills of solid rock, it has a comparatively small resident population, no expensive manufacturing or residential development that would tend to enhance real estate values, no expensive railroad to relocate, there are no large sources of pollution in the watershed and the necessary lengths of dams to create a reservoir at this point are comparatively short. Like all the other reservoir sites in this immediate vicinity, it has little water supply from its own watershed, but is more favorably located with respect to the watersheds to the westward. It is so situated that it may be easily supplied from any of the southern group of gravity supplies or by pumping from the Lower Raritan or the Upper Passaic. A reservoir at this point could be constructed, without any special difficulty, of sufficient size to fully equalize the flow from more than 200 square miles of drainage area. In other words, here at one point could be developed almost as much storage as is now utilized throughout the whole of the North Jersey District, and at an elevation sufficient to supply by gravity all of the Six Counties with the exception of the comparatively small high portions. It is a well known fact that storage in such a large single reservoir can be constructed at much less cost per million gallons than in a series of smaller reservoirs scattered throughout several watersheds.

"The elevation of flow line in the proposed Chimney Rock Reservoir would depend upon the design of the whole project, but it would probably be found most economical to plan for the largest feasible reservoir and to omit portions of the tops of the dams from the first construction program. Surveys of the sites of the proposed dams have been made and estimates of cost of the reservoir have been prepared in considerable detail for several elevations of flow line. With a flow line at Elevation 320 there would be available storage of 66,000 million gallons. This would fully supply the storage requirements of the Six Counties for many years to come.

"The water for the Chimney Rock Reservoir could be diverted through aqueducts from the watersheds of the North and South Branches of the Raritan, with possible supplemental supplies pumped from the nearby lower waters. Later extensions of the system to pick up all of the watersheds of the southern group would require provision for local storage within these watersheds so that water could be stored in these more distant reservoirs during wet periods, to be later released to supplement the dry period flow of the nearby watersheds."

The estimated cost of Chimney Rock reservoir and connections to 160 square miles of drainage area, with aqueducts to the center of the Six Counties, is \$46,000,000. This is estimated to yield 150 million gallons a day. Bringing in the more distant watersheds and a small amount pumped from the Delaware river, the yield could be brought up to a total of 750 million gallons a day, with an estimated cost of about \$184,000,000. The cost could be reduced to about \$172,000,000 if a single aqueduct line be

carried from each reservoir, connecting it with the next in the series; but this is not believed to provide sufficient flexibility for drawing from any reservoir at will.

Comparing cost of the Chimney Rock and Long Hill projects, the commission estimates the capital cost per million gallons per day of the Chimney Rock project providing 150 million gallons per day as \$305,000; while the Long Hill project, developed sufficiently to produce 168 million gallons per day, would cost \$525,000. When each development had reached a total yield of 750 million gallons per day, the cost for the Chimney Rock project would be \$245,000 and that for the long Hill \$207,000. "It would be very uneconomical and most unwise to expend such a sum as \$130,000,000 to \$155,000,000 in advance of such demand (for 750 million gallons per day) since, before its use to a point approaching capacity, interest charges of another \$100,000,000 or more would have to be paid." Moreover, the Long Hill reservoir would be so large that if the project be developed to the point of furnishing 109 million gallons per day, it would require about eight years to fill the reservoir if the entire supply be devoted to this purpose; and would require more than five years for filling if the supply be developed to 168 million gallons per day.

"The quality of the water from the sheds to be made tributary to the Chimney Rock reservoir is excellent; so good, in fact, that if the 150 million gallons a day project were to be built the long storage provided in this magnificent reservoir, together with aeration, would produce a water of so high a quality that filtration during the early years would be unnecessary.

"The Chimney Rock project would furnish much needed local storage near an important section of the Six Counties. It would have sufficient elevation to supply all lower areas in that part of the district without pumping. By connecting the new supply with the Wanaque aqueduct, through a large conduit built across the center of the district, a general distribution and exchange of waters would be possible, providing a factor of safety against any great emergency interfering with one or the other equal to that of the best water systems anywhere."

The commission consists of Berkeley W. Moore, Jr., chairman; Wood McKee, Thomas L. Raymond and Charles Wagner. Arthur H. Pratt is chief engineer and Morris R. Sherred consulting engineer.

To Gauge Greensboro's Water Supply

The city of Greensboro, N. C., has recently signed a contract with the Department of Conservation and Development of the State of North Carolina whereunder the latter will supervise the installation, maintenance and operation of automatic stream gauging stations on Reedy Fork and its tributaries, from which the city obtains its newly established water supply.

In addition to the cost of constructing and equipping the gauging stations mentioned in the agreement, the city of Greensboro agrees to appropriate \$75 annually to cover field expenses of the engineers of the Department of Conservation and Development and its cooperating Federal agencies.

Improving Boston Metropolitan Water Supply

Report of commission recommends project for supplying metropolitan district and Worcester.

The Metropolitan Water Supply Investigating Commission was appointed by the governor of Massachusetts in the summer of 1924 to report upon methods of providing adequate water supply for the Boston metropolitan district and the city of Worcester. This commission consisted of Charles R. Gow of Boston, E. E. Lochridge of Springfield, and George F. Booth of Worcester, while Allen Hazen of New York was employed as consulting engineer.

A report had been submitted two or three years previous by what was known as the Joint Board of 1922, which recommended building a large storage reservoir on Swift river for holding the flood flows of that river and of Ware river, but this had been opposed by manufacturers and others in the central portion of the state because it would withdraw water from this section to the Metropolitan District when other supplies were available nearer at hand. The opposition appears to have been justified in that the report just submitted recommends the use of these nearer supplies not only because of the opposition referred to, but also because the cost would be less, especially the cost of the development necessary within the next fifteen or twenty years.

Mr. Hazen estimated that the population of the present metropolitan water district would approximate 2,140,000 in 1970. The district is now consuming approximately 130 million gallons per day; in addition to which Worcester, because of shortage in its own supply, has been compelled to purchase from 5 to 6 million gallons from the district for several months past, pumping the same from the Wachusett reservoir into its own system.

Also in addition to the nearly twenty cities and towns now supplied by the metropolitan water system, eleven more within ten miles of the state house would apparently need to draw from the supply of the metropolitan water system before long, these being Braintree, Cambridge, Canton, Dedham, Needham, Wakefield, Waltham, Wellseley, Weymouth, Winchester and Woburn.

As against this consumption, the present sources of water supply which are of satisfactory quality can be depended upon to furnish an average output of not more than 119 m. g. d. during a series of exceptionally dry years; having available, however, about 26 m.g.d. from the South Sudbury system, the present natural quality of which is so unsatisfactory that for many years past it has been used only for short periods during extreme emergencies. It is apparent, therefore, that the needs of the city of Worcester for

an additional supply are immediately imperative, while, even if the South Sudbury supply be made satisfactory in quality, the metropolitan district may require a supplementary supply within four or five years.

The report recommends that purification works be built for purifying the South Sudbury supply at a cost of approximately \$3,500,000, which would bring the total capacity up to 145 m.g.d., sufficient, according to the estimates of the commission, to meet the water needs of the district until about 1929.

To meet the immediate needs of Worcester and also to add to the metropolitan supply, it recommends the construction of a dam across the Ware river in the vicinity of Barre Falls, whereby a large reservoir would be created which would furnish a supply of 45 m.g.d., about 5 m.g.d. of which would be used at once by Worcester and increasing amounts as the demands of that city increased, which would flow by gravity to the existing reservoirs of the Worcester system. The balance not so used could be drawn by gravity into the Wachusett reservoir, thus adding 35 or 40 m.g.d. to the supply of the metropolitan district. The estimated cost of developing this supply is \$14,000,000.

Following this, it will be possible to secure 47 m.g.d. by diverting certain branches of the upper Assabet river into the Wachusett aqueduct which passes through the water shed of that river, the cost of this development being estimated at about \$8,500,000.

When the supply needs further augmenting, the Ipswich river above the town of Topsfield can be developed to yield 80 m.g.d., of which 30 m.g.d. may ultimately be required by the communities in or adjacent to the Ipswich valley. The amount used by the metropolitan district would have to be pumped into its system. This development would cost about \$19,000,000.

An additional 50 m.g.d. could be obtained by adding 30 feet to the height of the present dam of Hobbs Brook reservoir of the city of Cambridge water supply, the reservoir being kept full by pumping water from the lower Sudbury river during seasons of flood. The cost of this development is estimated at about \$12,000,000.

These would give a total additional supply of 202 m.g.d. at an aggregate cost approximating \$53,500,000. As compared to this, the cost of obtaining approximately 200 m.g.d. from the Swift, Ware and Millers rivers, as recommended by the Joint Board in 1922, was estimated at \$60,000,000.

The water obtained from the Assabet, Ipswich and Hobbs Brook would require filtration; but for that matter the Wachusett reservoir supply now used will have to be filtered before long unless large sums are expended in the near future for purchasing the property surrounding the reservoir.

In addition to the development of the above supplies, it will be necessary to bring them into the district. The Weston aqueduct is already too

small at points for the present demand upon it, and the conduits leading from the end of the aqueduct to the centers of distribution are used to their full capacity. Engineering studies indicate the desirability of constructing a deep pressure tunnel in the underlying rock between the aqueduct terminal and a point in or near the city of Everett, at an estimated cost of \$17,000,000. About \$700,000 could be used to advantage in correcting some present deficiencies of capacity in certain sections of the Weston aqueduct.

In discussing the recommendation by the Joint Board of the Ware and Swift river project, this commission states that the entire investment of \$60,000,000 for that project would have to be made substantially at once for an amount of water which would not be required for many years, and possibly never if the anticipated growth in population should not materialize; while the commission's recommendation involves an expenditure of only \$47,500,000 during the next ten years.

Including the amount necessary for carrying the additional supply into the district and other items, the total cost of the commission's recommended scheme would reach \$85,500,000 less the amount paid by Worcester for the water used by it. Similar additions made to the estimate of the Board of 1922, would bring the total up to \$98,000,000.

The commission included in its report the following recommendations:

"That a special construction commission be created with authority to improve and increase the present water supply of the metropolitan district and of the city of Worcester.

"That the commission should immediately construct a suitable filtration plant for making available the waters of the South Sudbury system.

"That the commission also should proceed immediately with the construction of a reservoir on the upper Ware river for the joint use of the city of Worcester and the metropolitan district.

"That an agreement should be entered into between the city of Worcester and the Commonwealth whereby the latter shall construct the said reservoir and its necessary appurtenances, the city contributing one-ninth of the actual cost of same in return for the right to take one-ninth of all the water thereby made available, with the further privilege of additional amounts of water when needed, in increments of one-ninth each, paying therefor one-ninth of the original cost for each one-ninth of the supply of water so taken and in addition contributing to the annual cost of maintenance and upkeep in such proportion as its taking of water bears to the capacity of the entire supply.

"That the commission be authorized to purchase land at a suitable point along the Weston aqueduct for the location of a future filtration plant of sufficient capacity to filter the amount of water capable of being carried by said aqueduct.

"That the commission be empowered to purchase or take by right of eminent domain such land, rights, easements or other property within the watersheds of the Assabet and Ipswich rivers as it may determine to be necessary for the proper protection of these sources against future encroachment by private interests and for preserving the sanitary quality of their waters.

"That the commission be instructed to study and to report their recommendations to the General Court on or before Dec. 1, 1926, as to the need, location and estimated cost of delivering the future water supply to the distribution system of the metropolitan district either by pressure tunnel or by pipe lines.

"That the Legislature appropriate the sum of \$27,-

500,000 and that proper authority be given the said commission for expending the same in carrying out the foregoing recommendations."

Jacking Culverts Through Embankments

It sometimes becomes necessary to place a culvert through a railroad or highway embankment which is already in use, either to provide drainage that theretofore did not exist, or to enlarge or improve an existing culvert. The common method is to dig a trench through the embankment, place the culvert and backfill the trench. This method has many objectionable features, the most important being that it interferes with the operation of the railroad or highway while the trench is open, and that unless particular pains are taken with compacting the backfill, settlement is apt to continue for months afterward. The cost also may be considerable, especially if traffic must be maintained over railroad tracks under which the culvert passes.

A substitute for this method has been used in building a culvert through a railroad embankment in the West, which would seem to obviate most of these difficulties. This consists in forcing a pipe through the embankment by means of jacks, the dirt which the pipe displaces being removed through the pipe as it progresses. The method is similar in a general way to that used for forcing house connections under streets, except that with the latter the pipe is very small and the dirt is pushed aside; whereas, with the culvert, the pipe may be 4 feet or more in diameter and the dirt is removed through the pipe.

While this method does away with the necessity of carrying a deep trench through the embankment, shoring the trench, and maintaining traffic across the top of the same, it involves expenses of its own, requiring the use of two jacks and considerable 6x8, 6x12 and 12x12 timber for bearing blocks, jack support, jacking timber and lining timber. In each case, of course, picks and shovels, wheelbarrows, etc. are needed.

In jacking, a crew of six men has been found to be desirable, two excavating inside the pipe, two men removing the excavated materials in wheelbarrows to outside of the trench, and two operating jacks. At times, all the men may be used in excavating, in handling timbers, etc. For culverts up to 36-inch diameter, one 50-ton jack may be used; although two are desirable and especially so for the larger culverts, since with two jacks, one jack and jacking timber can be placed on each side of the trench and thus give freedom for removing the dirt. The jacks should have at least 2 feet of travel, since time is lost with each renewal of the jacking timber when the jack has reached the limit of its travel.

The pipe is placed in open trench on both sides of the embankment, these approaches being carried in to the point where jacking the pipe costs less per foot than excavating and bracing the approach. The ap-

proach excavation should be sufficiently wide to allow plenty of room for building the jack support, handling the jacking timbers and the jacks, etc. The pipe that is forced through the embankment is allowed to project a foot or so into each approach trench and other lengths of pipe are connected on here, and carried to the headwall of the culvert or other termination of the culvert pipe; a widening in the excavation equivalent to a bell hole being dug to permit the riveting of these extensions to the jacked pipe.

Jacking should always be done from the downstream side to avoid trouble from water. Care should be taken to see that the pipe follows the predetermined grade. To aid in this, a couple of 6x12 timbers are set in the bottom of the approach opening, reaching from the jacks to the end of the approach, to support the pipe and these are carefully set by level to the grade of the outside of the pipe. These keep the pipe in line until it is well into the embankment, and by sighting from these or across stakes set to grade in the line of the culvert, it can be determined at any time whether the forward end of the line is departing in any direction from line or grade. The pipe can be brought back to line or grade by excavating a little wider on the side toward which it is desired that the pipe move, while on the other side the excavation is left a little full, or a plank may be driven into the soil parallel to the axis of the culvert which will force the pipe over somewhat.

To take the thrust of the jacks, a jack support is set in place, sufficiently distant from the end of the approach trench to give room for inserting a length of pipe, the jack, and a short jacking timber. The sketch shown herewith (which was furnished through the kindness of the Armco Culvert & Flume Manufacturers' Association) gives a suggestion for constructing such a support, but the exact details will depend on local conditions.

In order to transmit the thrust equally around the circumference of the pipe, a bearing block is constructed of 6x8 timbers, generally a square or octagonal frame which bears against practically the entire circumference of the end of the pipe, with another block to receive the thrust of each of the jacking timbers. In the case illustrated, the culvert was an Armco corrugated iron pipe and an iron rod was placed around the pipe in the first corrugation from the end and tightened by means of a

turnbuckle in order to stiffen the end of the pipe. In the case of a pipe constructed of ordinary steel plates, a band can be shrunk on the end for the same purpose. The jacks are blocked up so as to lie parallel to and at the same elevation as the axis of the culvert and the jacking timbers are also blocked in position along the same lines. There should be several pairs of these timbers differing in length by the maximum travel of the jacks.

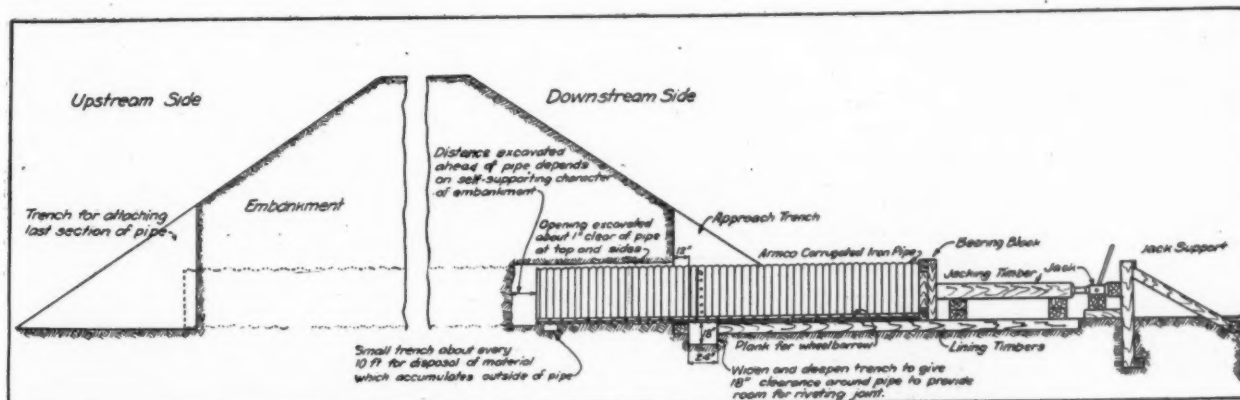
Where there is only one jack, dirt removed from the heading as the pipe progresses is moved to the end of the pipe and is removed from the pipe while the jacking timber is being replaced with a longer one; but where there are two jacks and jacking timbers the dirt can be removed continuously. In the case of corrugated pipe, a shallow trench is dug in the bottom and just ahead of the pipe at intervals of about 10 ft., to receive dirt that is dragged ahead by the corrugations.

The manner of excavating the dirt will be regulated by the material. In some cases ordinary short-handled picks and shovels, or even shovels without picks, may be all that is necessary. In heavy clay, special spades or even pneumatic spades may be worthwhile. If a boulder is met, this can sometimes be worked into the pipe and rolled out through the lower end, the space which it occupied outside of the culvert being filled with earth tamped in place as the pipe passes by it. If it is too large for this, it may be necessary to break the boulder by drilling and use of wedges. If quicksand is encountered it will generally be desirable not to excavate ahead of the end of the pipe. In fact, the pipe might better be kept as far ahead of the removal of material as the power of the jacks will permit. In extreme cases, it may be desirable to drive short poling boards ahead of the pipe.

When the pipe has been driven about 2 feet beyond the end of the upper approach trench, jacking is stopped and the extension pipe added at both ends, set and blocked at the proper grade, and the trenches are backfilled.

Lime For Earth Roads

The experimental treatment of earth roads with lime will be carried on next spring by the state highway departments of Virginia, Ohio, Missouri, Minnesota, Wisconsin and Pennsylvania. During the



SKETCH SHOWING EQUIPMENT AND METHOD OF JACKING CULVERT THROUGH EMBANKMENT

past year such experiments were conducted by the highway departments of Iowa and South Dakota in cooperation with the United States Bureau of Public Roads; and by the University of Missouri; the latter expecting to continue the work next year in cooperation with the state highway department.

Pennsylvania Highway Research

W. H. Connell, engineering executive of the Pennsylvania Department of Highways, stated last month that two important research projects are now under way by that department as follows: "Efficiency of 2 per cent calcium chloride integral in the mix as an accelerator and curative agent for concrete road slabs. This series will include transverse and compression tests of calcium chloride concrete in comparison with plain concrete at various ages to one year.

"Comparative transverse and compression strength of stone, gravel and slag concrete at various ages to one year, with a variation in depth of the transverse specimens."

Highway Research Projects

Some idea of the broad field for investigation which has been entered upon by the Highway Research Board is offered by a tabulation of highway research projects in the investigation of which it is co-operating with various departments, colleges, commissions, etc.

The subjects are classified under the five heads of Economics, Operation, Design, Design of Vehicles, and Construction. Under the head of Economics, the principal projects now under discussion can be grouped under the sub-heads of Traffic Studies, Cost of Transport, and Economics of Location. Under the general head of Operation, the sub-heads listed are, Control of Traffic, Maintenance Methods, and Safety. Under the general head of Design, the sub-heads are, Subsoil Studies, Base Course, Surface, Impact, and Reinforcement. Under Design of Vehicles we have, Air Resistance, Surface, Alignment, and Safety. Under Construction we find Materials, Mixing, Placing, Methods of Testing Roads, Drainage and Drainage Structures, and Reinforcement.

Under each of these sub-heads several investigations are under way. The longest list is that under the main head, Construction, and sub-head "Materials." Here we find investigations of bituminous materials being carried on by the Iowa and North Carolina state highway commissions, and the South Carolina highway department; and investigations of non-bituminous materials by the United States Bureau of Public Roads; California and Iowa state highway commissions, Minnesota, New Jersey and Tennessee state highway departments, Colorado State Agricultural College, Johns Hopkins University, Kansas State Agricultural College, Perdue University, Texas Agricultural and Mechanical College and the University of California. Also investigations of fundamental mechanical properties by the California highway commission and the Illinois department of public works; methods of tests, by the United States Bureau of Public Roads, Illinois Department of Public Works, Iowa State Highway Commission, and Massachusetts Institute of Tech-

nology; of preparation and treatment, by the Iowa State Highway Commission and the Wisconsin Highway Commission; and of proportioning, by the Illinois Division of Public Works, Iowa and North Canadian Highway Commissions, and the University of Tennessee.

Most of the non-bituminous investigations have to do with concrete pavements. These include studies of the expansion of concrete due to moisture, fatigue of concrete, measurements of consistency, abrasion tests of sand, methods of controlling hair cracks, a study of the accuracy of proportioning fine aggregate by inundation. The University of Tennessee hopes to make a study of fine dust as an asphalt pavement filler; and the Wisconsin commission to determine the best method of surface treatment of gravel roads.

Concrete Arch Girder Bridge

There was constructed last fall in North Dakota, a bridge built entirely of reinforced concrete with a span of 132 ft. which, while it has the appearance of an arch, really consists of a middle anchor span and two 33 ft. cantilever spans, one extending shoreward from each of the two piers. A true arch bridge was not thought advisable because of the difficulty of obtaining support for the thrust of the arch without excessive expenditure. Each span is made up of two beams, one on each side of the structure, the depth of the beam varying in a curve so as to give the effect of an arch. Expansion and contraction of the structure are provided for by a nest of steel rollers under the two main girders on the east pier. This bridge spans the Cheyenne river in Valley City. The roadway is 24 feet clear from curb to curb, with a 6-ft. sidewalk on each side.

It was considered impracticable to pour the entire bridge at one time, but each of the main girders and the attached sidewalk brackets was made by a continuous pouring, there being 110 cubic yards in each. The lower part of the floor beams was made in another continuous pour. The floor slab and sidewalks were poured in sections. As each short half-span acted as part of a cantilever, no supports at the end of it were permissible. A slab serving as a continuation of the pavement, and another to each curb and sidewalk, were built at each end of the approach and connected to it by a hinged slab. Forty-seven tons of reinforcing steel was used in the bridge and 1,278 tons of concrete.

Trunk Highways for Trucks

Trunk highways exclusively for trains of tractors and trailers were visioned as probabilities of the future by Major Elihu Church, transportation engineer of the Port of New York Authority, in an address before the Society of Automotive Engineers. These trunk highways would be toll roads and would be laid out with the same care as to grades and curves as are railroads. Trains of trailers would be dispatched on regular schedules. The highways would pass around cities rather than through them, and would be carried over or under transverse roads.

The necessity for such roads will, he believes, develop from the inadequacy of the present highways to accommodate both passenger vehicles and trucks.

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Municipal Work in Florida

Stories of almost incredibly rapid construction in Florida of homes, hotels, club houses and other buildings are found in almost every issue of the daily papers, but little or nothing is said about the street paving, waterworks and sewer extensions, provisions for disposing of garbage, refuse and ashes, and other necessary adjuncts of the growth of a community. But it is unbelievable that these things are being overlooked, and municipal engineers can realize what a problem is presented by the necessity of providing them as rapidly as they are demanded by the Aladdin-like construction of "additions" to old cities and development of new ones.

Then there is the problem, perhaps even more difficult and serious, of the tourist camps. Tens of thousands of automobilists have invaded the state and are camping out wherever they can find accommodations. Many camping grounds have been opened up by private parties with no adequate provision for sanitation, some in out-of-the-way places where the overworked health officials may easily overlook them. Under these conditions it will be fortunate if typhoid and other infectious diseases do not manifest themselves in many of these camps and spread to the adjacent cities.

The State Board of Health is alive to the danger and has added several sanitarians to its bureau of engineering, and the new chief sanitary engineer, E. L. Filby, is doing his best to impress upon the cities throughout the state the importance of acting in the matter. West Palm Beach has just built a tourist camp capable of housing over four thousand people, with full realization of the importance of providing adequate sanitation.

Believing that "Public Works" readers will be interested in these matters, we expect to publish several articles describing what is being done. In this issue we give a description of the new water supply works of Tampa. Among other articles to appear later will be a description of the West Palm Beach tourist camp, by Mr. Filby; the municipal works of Coral Gables; and other new water supply and sewerage works in various parts of the state.

To the Satisfaction of the Engineer

Louisville, Ky., some weeks ago, advertised quite extensively for bids for constructing sewers in that city, the estimated cost of the work being about \$300,000. There are a considerable number of contractors in Louisville, experienced in sewer work, and the advertisement for bids undoubtedly reached the eyes of a great many others throughout the country. In spite of this, there were only two bidders, and they bid unusually high.

Discussing this peculiar condition, "The Scraper" (organ of the Kentucky Association of Highway Contractors) attributes this disinclination to bid to the fact that, according to the contract, "the chief engineer was to determine the amount, quality, acceptability and fitness of everything, and that his estimate and decision was final and conclusive." This was vigorously objected to by a number of contractors and the commission endeavored to remove the objection by stating that the commission itself would act as a board of arbitration and review

the decision of its engineer. The commission apparently did not convince the contractors that it would be an unprejudiced judge and their opinion of the matter is reflected in their general refusal to bid.

The editorial comment of "The Scraper" on the situation seems to imply that the contractors had considerable doubt as to whether the engineer in whom so much authority was placed would exert this in a reasonable and equitable way. Whether or not they were justified in this opinion, the belief is coming to be quite general among engineers, as well as contractors, that such indefinite clauses and the placing of the contractor so fully in the power of one engineer is bad for all concerned. Such a contract is apt to increase the cost of work to the city, as in this case, because it unnecessarily increases the risk taken by the contractor who, under the most definite contracts, has enough risks to look out for; and it creates a condition which invites either attempted blackmail by the engineer or attempted bribery of the engineer by the contractor, and suspicion of both by the taxpayers.

Undoubtedly most contracts so written by engineers are merely copies of forms prepared under contracting conditions which we are now happily and rapidly outgrowing; but when deliberately and with purpose written into a contract, the purpose would seem to be either to prepare a foundation for blackmail or (which is more common) because the engineer is not sufficiently well informed of the more definite requirements of the work. In some cases the engineer can hardly be blamed, since it has been demanded of him that he prepare plans and specifications and advertise the work on such short notice as to make it practically impossible for him to work out all details of the plans and learn all the conditions which will be encountered. In such cases, the wise engineer will refuse to be driven into such an indefensible position but will demand that the interests of his employers as well as his own reputation, and justice to the contractor, demand that opportunity be given for such investigations and preparation of plans as will enable the contractor to know definitely what is to be expected of him. As an alternative, if immediate construction is a matter of prime consideration, day labor or a cost-plus form of contract may be resorted to.

District Development of Water Supplies

We have discussed several times in the past the desirability of study and developing water supplies on the basis of topographical rather than political boundaries, and of joint development of large, comprehensive projects by a group of communities rather than uneconomical piecemeal construction of systems that are unrelated and frequently inequitably apportioned.

Local pride, mutual distrust and politics are largely responsible for failure of communities to unite in advantageous joint developments; but the wisdom of legislatures in some cases and the compulsion of the law of demand and supply in others are bringing about more and more of such combinations.

Two of the largest and most notable of these are found in the Boston Metropolitan district and the Wanaque development in northern New Jersey. The former has been operating for years and has proved

the wisdom of its originators. The latter has not yet begun to deliver a supply of water, but its capacity has already been spoken for and will undoubtedly be used to the utmost in a few years.

Those in charge of both these developments realize the need for early extensions and have reported upon the matter recently. Abstracts of these reports are contained in this issue.

We were impressed with the coincidence that in both of these reports emphasis was laid upon the desirability of providing a plan that would permit of progressive development of the total capacity of the project, even though the ultimate cost of construction might be increased thereby. There is no doubt in our minds of the wisdom of this, but it is a point that is often overlooked by engineers. If we assume that a project looking fifty years ahead can be constructed in two parts, the first furnishing a supply sufficient of the first twenty-five years, and that this and the later completion should each cost three-fourths of the cost of completing the project at once, making the total cost 50 per cent greater, the progressive construction would still be preferable. For not only would the total cost, including interest, depreciation and operation, be no greater; but the first twenty-five years would probably furnish experience and data that would make possible better adjustment to the conditions that had developed meantime, and other improvements in the plan, which no wisdom or foresight could have been expected to provide in the immediate construction of the entire project.

For a Federal Department of Public Works

A committee of engineers, with a total membership of nearly 1,000, are being organized in every state by the American Engineering Council to carry on a nation-wide movement for the reorganization of the Department of the Interior with a view to securing changes in the distribution of federal administrative functions "so that the enormous public works activities of the government, involving the expenditure of many millions annually, may be effectively coordinated, efficiency promoted, and waste wiped out." A bill to this end is to be introduced in Congress by Senator Wesley L. Jones of Washington, and Rep. Adam M. Wyant of Pennsylvania. The bill is said to be endorsed by Edward Mead, U. S. Commissioner of Reclamation, and by Secretary Work.

By the proposed reorganization, the Bureau of Public Roads, now in the Department of Agriculture, and the office of the Supervising Architect, now in the Treasury Department, would be transferred to what is now the Department of the Interior, the name of which would be changed to the Department of Public Works and Domain. To this would also be given the functions of the Rivers and Harbors Improvement, Mississippi River Commission, and California Debris Commission, at present under the jurisdiction of the War Department; also the Office of Buildings and Grounds of the District of Columbia, the Superintendent of the State, War and Navy Buildings, the Rock Creek and Potomac Parkway Commission, Office of the Architect of the Capitol, the Board of Road Commissioners for Alaska, and

other similar works scattered among the federal departments.

It is provided by the bill that engineering officers of the U. S. Army may be detailed by the Secretary of War to non-military duties connected with such public works, with the approval of the Secretary of Public Works and Domain.

This committee expects to work in cooperation with a committee of the American Engineering Council and the Public Works Advisory Council, continuing the work of the National Public Works Department Association, begun in 1919. It is claimed that the Jones-Wyant bill, if passed, will create a department "under which the major public works functions will be consolidated and conducted according to the well settled precepts of a modern industrial organization."

Day Labor vs. Contract Work

The relative merits of day labor and contract work for public construction are being weighed by a special committee of the Chamber of Commerce of the United States as an economic problem affecting all taxpayers.

How important it is may be gathered from the fact that of the \$6,000,000,000 expended annually on public works by the American people, approximately \$500,000,000 is expended by the day labor method.

"The federal government," the committee finds, "is doing its own reclamation projects, flood control and shipbuilding. Approximately \$100,000,000 has been so expended by the Reclamation Service. The 1924 report of the Army Engineers indicates that approximately two-thirds of annual expenditures of \$40,000,000 to \$60,000,000 for river and harbor improvement and maintenance are being made by day labor. Some states are building their own highways. Irrigation districts are building huge dams and canal systems without taking bids. Counties are using their own forces in the construction of hospitals, roads and bridges. City officials are building schools, streets, engine houses by the same method.

"It is obvious that the economic soundness of a method employed for the expenditure of such a vast part of the taxpayers' money is a matter of important public concern."

Chicago Through-Traffic Routes

The Chicago Plan Commission has proposed a new through traffic system for that city which it is claimed will save 40 million dollars a year in the cost of handling city traffic. Various city departments have estimated that traffic congestion in the city causes an economic loss of 120 million dollars a year. Test trips made during the preparation of the proposed system showed that the proposed through traffic routes could save one-third the time now required for vehicular traffic.

These routes provide 44 "boulevards" for rapid traffic, criss-crossing Chicago from city limits to city limits. Twenty-five of these routes run east and west, 15 run north and south, and the other 4 are diagonals. They tap every existing and proposed county highway which reaches the city limits. They are continuous, direct and will be well marked and

protected both day and night with illuminated stop signs at street intersections; while stop-and-go signals will control traffic at important intersections.

It is proposed to improve or replace existing pavements on these boulevards and provide adequate street lighting. A roadway width of 40 feet has been recommended as the standard for streets 66 feet wide, leaving 13 feet for each sidewalk.

It is expected that the through traffic system will go a long way towards solving Chicago's street traffic problem, facilitating movement of vehicles in every direction, diffusing traffic more generally throughout the city, providing preferential routes for rapid traffic, and freeing street car streets for street car operation, heavy commercial traffic, slow moving vehicles and local traffic. They will open up many isolated and run down sections of the city, increasing property values therein and giving the residents convenient access to lakefront parks, interior parks and playgrounds, and forest preserves surrounding the city.

Municipal Finance for Street Improvements

Abstract of a paper by George C. Warren, before the convention of the American Society for Municipal Improvements.

In presenting a paper with the above title before American Society for Municipal Improvements, George C. Warren repeated the statement made before the society in 1917, which he still believed to be true—that payment for street improvements or renewals entirely from general funds of the municipality is a very uneconomical system of financing, as is proved by the fact that practically every city which has followed this plan for a considerable number of years either is poorly paved or is carrying the load of a heavy bonded indebtedness created for laying pavements, and generally both.

Modern demands for street pavements are such that no city can accomplish much toward meeting them through its annual tax budget. Different municipalities follow one of three general modes of payment, the mode frequently being determined by state and municipal laws and charters. These modes are: (1) General tax, the city paying the entire cost, with no frontage or district assessments against abutting property. (2) District assessment. (3) Special improvement assessment against abutting property for the whole or varying percentages of the cost.

GENERAL TAX

This seemed to the speaker the least desirable of the three from the point of view of the taxpayers' interest, because it necessarily limits the amount of improvement to either the funds available from the city budget and annual tax rate, or to those available from sale of city bonds. The first is always inadequate to meet the economic demand for street improvements; while if bonds are issued they are

usually made for a period far beyond the reasonable life of the pavement, or excessive bond issues are made to be met by succeeding generations for improvements which will be generally worn out by the present generations—usually both.

Although no class of pavement should be adopted for a city street which can not reasonably be expected to endure for at least ten years under moderate traffic conditions, Mr. Warren believed that paving bonds should never run for more than ten years, or fifteen years at the most, since conservatism demands that culmination of payment should be before rather than after the product of the loan is dissipated. The late Nelson P. Lewis was quoted as saying "New York has many miles of streets which have been reconstructed two and sometimes three times from the proceeds of long-time bond issues before the first bond issue has been paid."

One advantage in municipal bond issues is that they can be secured at the lowest rate of interest and the contractor is paid on monthly estimates as the work progresses.

The contractor should always be so paid, for he should be engaged because of his experience and reliability as a contractor and not as a financier.

DISTRICT ASSESSMENTS

The district assessment plant is working out successfully in a number of states. In Arkansas for instance, improvement districts are created, generally by the appointment of a district improvement commission consisting of three taxpayers, through a petition filed by property owners. This commission has full authority to engage engineers and attorneys, make improvement contracts and issue district bonds for paving streets in the district designated in the petition. Generally the bonds are payable semi-annually during a period of ten years and are met by one to ten year serial assessments against the abutters. This system has the advantage of supervision by local taxpayers and better salability of securities than generally prevails in cases of assessments against individual properties.

ABUTTERS ASSESSMENTS

This is the system most generally in vogue in cities throughout the country. In New York, Boston, and some of the other older cities, it applies to the first pavement only, which means that modern pavements replacing macadam and other antiquated types are at the expense of the city at large and so practically come under the first head of general tax. Furthermore, the tendency is toward property owners selecting or urging cheap and inadequate types of pavement in the expectation that, when worn out, the city will replace them with modern pavements at the general expense. In recent years, however, some cities have ruled that the first pavement referred to shall be of adequate modern type, and the taxpayers have realized that the practice of laying inferior pavement originally is uneconomical.

Generally, assessments are made on the basis of assessing on the abutters the whole or not less than two-thirds of the total cost of the original pavement; renewals, resurfacing and minor repairs being paid for by the city at large. Usually the abutter is given the option of paying in cash or in annual instalments (seldom less than five or more than ten years) with

a reasonable interest rate. To provide for the deferred payments, the city issues paper variously called tax bills, assessment bonds, improvement bonds, assessment certificates, etc., and pays the contractor in cash on monthly estimates. Where this paper is guaranteed by the city it secures the lowest possible interest rate.

In Oregon, the municipalities pay for paving by issuing to the contractor, upon completion of the work, a tax bill for each piece of property improved, which is payable in full within thirty days. During these thirty days, taxpayers may pay the tax in full or sign an agreement to pay in ten annual instalments; and at the end of the thirty days, the city issues bonds to cover the amount so paid or agreed upon. Where property owners have not taken such action, their property is subject to immediate foreclosure, the procedure being handled by the city in behalf of the contractor. The money so obtained by the city is then turned over to the contractor with interest. As the city does not bond any property for more than sixty percent of its assessed value, it is amply secured, while financial institutions will advance to responsible contractors the necessary construction funds on the strength of such assessment bonds.

In many states, the cities issue assessment bonds for each parcel of land, giving odd amounts such as \$94.53, payable in ten annual instalments for which coupons are attached, while another set of coupons covers semi-annual interest of \$2.70 for the first year down to 27 cents for the last year. While the bonds are perfectly good and interest rate satisfactory, the average investor does not want returns in such dribbles and odd amounts and the contractor therefore has to sell the bonds at a considerable discount. Of course the taxpayers themselves pay this discount, for the contractor has allowed for it in his bid.

Special assessment bonds which are not a direct obligation of the city are generally considered a less safe form of investment, and as there is no adequate demand for them it is necessary to have the interest rate several points higher than could be secured by the city on its general bonds.

In several western states there has often been some delay in the collection by the city of annual instalments due on account of these bonds, and unless a fund is created to take care of the interest coupons and the annual payments on the principal, the city's credit may be seriously injured and the selling price of future bond issues affected.

Mr. Warren recognizes that it is not easy to change an old system, as for instance, changing to the abutters assessment system after many of the older properties had been provided with pavements at the general expense; but the advantages of the former are so great as to outweigh this objection, since it secures the needed improvements more rapidly and permits a reduction in general taxes.

RECOMMENDED PLAN OF FINANCING

In conclusion he made a plea for saner finance and laws along the following lines.

1. Assess cost of all pavements, resurfacing and renewals (or at least the greater percentage of cost) against the abutting property which is directly benefited by the improvement.

2. At option of each abutter, exercised within a month of completion of assessment, permit payment of whole assessment in cash or in say ten (10) annual instalments with interest.

3. At the expiration of the one-month option period, the City issue its "General Obligation Bonds" in round sum pieces (say \$100, \$500, and \$1,000) with interest at as low a rate as will insure sale of bonds at not less than par. The terms of bonds to be serial coincident with time of due dates of assessment.

4. A law providing that such "Improvement Bond," being secured by assessments, against abutting property worth many times the assessments, shall not be included against the limit of bonded indebtedness provided by law. This on the same principle that Water Works and other bonds issued against property, having a direct salable and income-bearing value, are exempted or deducted from total liability in determining the amount of net liability to which the legal limit is fixed by law—generally a certain percentage of assessed valuation.

5. For the purpose of most economic contract, the City issue its temporary notes or bonds, from the proceeds of which the contractors will be paid in cash on monthly estimates, leaving them in the position of contractors, rather than contractor-financiers.

6. Make it absolutely obligatory upon the municipalities to foreclose immediately upon delinquency of one instalment.

7. Provide for the setting aside by the City out of its general fund, a fund to be known as a revolving fund to take care of delinquent assessments on local improvement bonds.

8. Provide a section in the code dealing with the sale of property by the County for delinquent taxes so that the City must at the time of the sale protect all liens against the property including the street improvement taxes which may have been issued and for which the property to be sold is liable.

The speaker believes that along this line is the one way that Cities can generally modernize their pavements to meet the public demand and on the basis of least cost to the City and abutting taxpayers and the least annoyance and expense to all concerned. It will be noted that such a plan has the following advantages:

(a) Only limit of improvement available is the number of abutting taxpayers who are required to pay the cost of improvements and who generally welcome this economic improvement of their properties.

(b) Every taxpayer having an immediate or prospective financial interest, keeps himself well informed regarding pavements, with a maximum of intelligence in action as to types and time for improvement.

(c) Lowest practicable cost consistent with first class improvement.

(d) In so far as this system in more or less modified form has been adopted, we have the best paved Cities in the country. Portland, Oregon, for instance, had practically no paved streets in 1902, and in the succeeding fifteen years practically every street in the City was well paved and the demand for modern pavements in that rapidly growing City has become such that the first action of managers of real estate addition is to provide streets and pavements, and of course, sewer, water and gas and then proceed to sell lots which "go like hot cakes" if paved, but "no sale" if not paved.

Utica, N. Y., in 1886, had but one paved street and with a limit of \$150,000 per annum, of which the City at large paid \$50,000 from its Tax Budget and assessed \$100,000 against abutters (with deferred option instalments of one to six years at 6% interest) in the succeeding fifteen years paved practically all of its streets and is now resurfacing pavements laid fifteen years or more ago and is also paving new streets about as fast as they are laid out.

Brick Paving in France

Last summer a French mission that was sent to this country spent several weeks studying American fire clays and shales, and methods of manufacturing and laying paving brick. It is reported that, apparently as a result of this visit,

a test brick pavement has been laid in France on Pas de Calais at Brebieres. It was constructed in accordance with the specifications of the National Paving Brick Manufacturers' Association (which have been reprinted in French), using a concrete base, sand bedding course, 3-inch plain wire cut brick and bituminous filler.

Nevada Highway Department

**Fall preparation for next year's work.
Preliminary excavation estimates.
Sand and oil surfacing.**

The Nevada Department of Highways several years ago adopted the policy of having surveys and plans approved and the construction program for a given year ready for advertising during the preceding winter or the early spring. In order to accomplish this, it has been necessary to augment both the field and the office force. During the summer of 1923 six survey parties were in the field and were gradually disbanded until on February 1, 1924, only two were engaged at location. With this start, two or possibly three parties will be required for carrying on future location work. During the years 1923 and 1924, 804.4 miles of highway location were completed by the survey department.

The work of preparing plans and estimates has been standardized as much as possible, utilizing experience gained in previous work. A great deal of consideration has been given to preparing designs upon which contractors may base economical and balanced bids. As far as possible, uncertain elements are eliminated from plans and specifications, while definite quantities and figures are given in place of approximations.

Especially worthy of mention in this respect is the method of computing and listing the estimate of excavation quantities, which is usually the largest single item of work in this state. Under the Nevada system, the excavation estimate shown on the original plan is the final estimate and the contractor knows at all times how much work he has done and the amount remaining unfinished. Quantities are computed on the basis of actual embankment volume rather than on the estimated volume of excavation necessary to build the embankment. This method entirely eliminates the bugbears of shrinkage and swell with which grading contractors often gamble, and for which they have allowed liberally in their bids in the past.

Bids on gravel surface operations are divided into the items, "preparing subgrade," "loading gravel," "hauling gravel," and "spreading gravel." The department assumes responsibility for locating and testing gravel pits and the contractor's bid prices reflect the fact that he is bidding on an estimate and not on a guess.

All this requires additional preliminary engineering work both in the surveys and in preparing plans and

estimates, but the cost of this is negligible when compared with the resulting reduction in construction costs.

As part of the work of the testing department there is conducted what is termed a material survey. Such survey is made for each project and consists of a preliminary search for all possible local materials which may be used in construction, including surfacing gravel, if the road is to be graveled, or sand and gravel or stone where concrete is to be used. These materials are sampled and tested at the laboratory and if they are acceptable, all information regarding them is put in condensed form and submitted, together with the plans, to contractors desiring to bid upon a project.

SAND AND OIL SURFACING

At the beginning of 1925 the total of all highways completed or under construction was 915 miles, of which 10.16 miles had been surfaced in 1924 with a sand and road oil mixture, which is of special in-

terest. This section, which is on the old abandoned grade of the Las Vegas and Tonopah Railroad, presented unusual difficulties because of its isolation, the sandy material of which the entire country is composed, and the absence of a sufficient amount of material suitable for surfacing to be found in the vicinity of the project.

Asphaltic road oil was shipped in tank cars to Carrara, the nearest railroad siding, and there transferred to distributor trucks and hauled to the project, the average length of haul being about 19 miles. The oil was uniformly distributed over the roadway in several applications and mixed with the sand until a thickness of about six inches of thoroughly mixed oil and sand was produced. (The report of the Highway Department, from which this information has been obtained, does not mention the amount of oil used in this construction.) The road was then dragged and rolled until well compacted. The result is apparently very satisfactory.

Efficient Production of Pavement Concrete

On most concrete paving jobs the daily output could be increased 25 to 100 percent by greater efficiency in the mixer operator, minimizing mixer troubles, using larger water pipe, and eliminating delays due to lack of prepared subgrade, delay in delivering materials, and arbitrary interference by inspectors.

Studies made by the Bureau of Public Roads indicate that there are few concrete paving projects on which the daily average output can not be increased 25 per cent. On many jobs the output can be increased 50 to 100 per cent, and this can be accompanied by some reduction in the amount of both labor and equipment employed.

Full production on a concrete paving job is 48 batches an hour. By whatever amount a contractor fails to reach this standard, he is failing to reach full efficiency in production, assuming that the specifications require a one-minute mix.

The mixer is the bottle neck on every concrete paving job. No matter what material supplies are available, what correlated equipment is on the job, what skilled labor is available, nor what other conditions may prevail, be they ever so favorable, the mixer sets a rigid limit on production which can not be honestly avoided.

To reach full production it is imperative that the discharge be opened and the skip started up at the same instant.

There is an average lag of 5 seconds in charging the mixer after the skip reaches the vertical position, and a lag in discharging which averages 2 seconds. The discharge lag partly offsets the charging lag and the difference should be added to the mixing time.

A slow, indifferent, or incompetent mixer operator may easily lose \$35 a day on a job with a daily pay roll of \$200.

Loss of time due to mixer trouble averages about 5 per cent and runs as high as 10 per cent. A contractor with a daily pay roll of \$200 may lose from

\$2,000 to \$4,500 a season from this cause alone. Careful maintenance of the mixer pays.

Long lines of 2-inch water pipe are a "hang-over" from the days of the 3-bag mixer. The high pressure necessary to force water through them bursts hose, splits pipe, opens joints, and springs the valves on the mixer. Leaky valves are probably the outstanding cause of nonuniformity of consistency. Three-inch pipe will carry an adequate water supply at reasonable pressure and reduce water troubles.

Delays due to lack of prepared subgrade and slow delivery of materials due to inadequate truck supply and other causes are inexcusable on a well-managed job.

Arbitrary interference by inspectors and abuse of discretionary clauses in specifications were the cause of considerable loss to the contractor on more than half the jobs studied by the bureau.

The above is a summary of a report, by J. L. Harrison, of observations made on going projects by the division of control, Bureau of Public Roads. The report is too extensive for reproduction in full, but the following is an abstract of the more important points of the discussion upon which the conclusions above stated were based.

About 92,000,000 sq. yds. of concrete pavement is being laid a year, at a cost of approximately \$250,000,000. If the efficiency of production could be so increased as to reduce the cost only 10%, there would be a saving of \$25,000,000 a year (of which the taxpayer would receive a large share); or the amount of pavement laid would be increased by 10,000,000 sq. yds., or about 850 miles.

Full efficiency necessitates the use of the most effective equipment for the job in question, operated so as to produce continuously its greatest possible output, and with expenditure of the least amount for wages by which such output can be secured.

A mixer is operating with 100% efficiency when the time of each batch is 15 seconds plus the time specified for mixing—for a 1-minute batch, 75 seconds, or 48 batches an hour. One full minute of mixing is believed to be sufficient and is used as the basis of this discussion.

Loading the skip can generally be done in 40 to 50 seconds, while the previous batch is being mixed; unless the contractor uses the antiquated system of piling the cement in sacks along the road.

A modern mixer in reasonably good condition can raise the skip to vertical position in 9 or 10 seconds. During the last $1\frac{1}{2}$ to 2 seconds the material is leaving the skip for the mixer; but the full discharge of the skip requires 3 to 6 seconds more, depending on the dryness and coarseness of the sand and design of the skip. One old-fashioned 8-bag mixer requires 40 seconds. But a number of modern makes of mixers can be relied on to limit this time to 5 seconds.

When the timer bell rings, the operator moves the discharge lever and a second or two later the material appears in the discharge chute. The interval or "discharge lag" should be kept under 4 seconds and may be as low as 2.

A wet mix can be thoroughly discharged from a good mixer in 9 seconds, but 10 seconds is the minimum obtainable with the best mixer if the consistency meets present slump requirements. Most buckets are too small and the discharging concrete backs up into the chute, retarding the discharge. All mixers dribble a good deal. The loss of time due to dribbling can be prevented if part of each batch—a small amount—is left in the mixer and mixed with the next batch. The 10 seconds of discharge plus 4 seconds discharge lag occurs during the ten seconds of charging and 5 seconds charging lag, giving the 15 seconds to be added to the time of mixing.

To attain this standard of efficiency, the mixer must be one that will raise the skip in 10 seconds and discharge the mixture in the same time. The operator opens the discharge and starts the skip at the same time; and closes the discharge just as the skip reaches its vertical position. The amount discharged from the skip during the last $1\frac{1}{2}$ or 2 seconds will not have time to mix with the previous charge before the discharge opening is closed.

Several weeks were spent with a stop watch in timing a number of actual jobs. On one typical job, timed during eight separate days, the number of batches per hour averaged 27.5, or a lapse of 42.7% from 100% efficiency. Of this loss, 3.5% was due to excess length of mixing cycle, 8.4% to mixer trouble due to operatives, 4.9% to mechanical trouble with the mixer, 13.6% to inadequate truck supply, 4.0% to truck delays other than shortage, 2% to water supply trouble, 1.6% to lack of prepared subgrade, 4.0% to inability of finishers to keep up with the mixer, and 0.7% to lack of materials caused by mismanagement.

Of 22 different job studies, the lowest production efficiency was 26.9% and the highest 92.7%. Of the time lost by the former, 60% was due to truck shortage and about 12% to mechanical trouble with the mixer.

Mechanical trouble with a mixer can not be avoided altogether, but increases as the mixer wears out. With a pay roll of \$200 a day and a depreciation account of \$100, a loss of 5% due to this cause, which appears to be about the average, amounts to \$15 a day, or \$2,250 in a 150-day season—enough to pay for a new mixer in two years. Money spent in keeping a machine in good condition is therefore well worth while.

Contractors are prone to provide inadequate facilities for delivering materials. Of the 22 time studies made, only six showed adequate delivery service, and in ten of them the shortage exceeded 10% of the number needed to keep the mixer in continuous operation.

Delay due to the water supply is commonly caused by shifting the hose or by poor pressure. The latter may be due to capacity or condition of pump, or to small size or leaky condition of pipe. Use of a 2-inch line instead of a 3-inch often necessitates high pressure which opens joints, bursts hose and causes excessive wear of pumps. Leakage at the mixer valve causes undesirable wetness of mixture and nonuniformity of consistency.

Loss due to delay in finishing is unusual. Finishing machines seldom give a contractor trouble. The essence of rapid finishing is uniformity in consistency, about 1-inch slump being best. A mix dryer than this has been found not only to require a longer time for finishing but also to fail to compact thoroughly in the bottom third.

Inspectors generally fail to realize the delay that may result from changes, often unnecessary or unwarranted, that they insist upon. To change the practice on a going job, the men must be trained to perform the new duties properly, and the force may have to be rebalanced. The time to decide on methods and practices is when the specifications are drawn, and the exact interpretation of these in actual production should be made definite and clear at the beginning of the work. After that neither inspector nor state has any right to modify the requirements unless infraction of specific provisions or commonly accepted interpretations of the specifications can be shown. In one case the writer learned that an inspector insisted that the contractor should not produce more than 40 batches an hour; and on more than half the jobs studied, losses of some consequence resulted from unwarranted interference by inspectors.

Some generalizations made in the report are that: Mixer operators are quite generally undertrained; transportation generally is inadequate, and is apt to be poorly operated; the water supply is generally inadequate, especially for curing.

Timekeepers, superintendents, and inspectors should have and use stop watches. In the only job so far studied by the bureau's representatives on which the output was consistently maintained at above 90% of full efficiency, the superintendent had and frequently used a first-class stop watch.

Difference in Strength of Paving Concretes

Experiments conducted by California Highway Department to determine relative effect of sand, gravel, and cement, respectively, on the strength of concrete.

The testing laboratory of the California Highway Department has under way and has completed in recent months a number of important research investigations, and reports of these are to be made public because of their undoubted interest to those engaged in highway construction. We expect to publish the more important of these from time to time. The following is a report by C. L. McKesson, testing and research engineer, on the reasons for differences in strength found in testing concrete from two paving projects.

The highest average strength of field concrete from a California paving project laid and tested during the season of 1924, was about 5,000 pounds. The lowest average strength from a project built during the same season was about 2,700 pounds. On each project, the same amount of cement per cubic yard was used.

Believing a study of the reasons for this wide variation in strengths would be of value in connection with efforts of the department to produce uniformly good concrete, liberal samples of materials used in each project were secured and a complete series of laboratory tests, which seem most illuminating, have been completed.

In the following report of this research the paving project having the higher strength will be designated as Number 1, and the one with the lower strength as Number 2. Materials used on the two projects likewise will be designated by the same numbers; Sand Number 1, Gravel Number 1, and Cement Number 1 being those used on project Number 1, and Sand Number 2, etc., referring to the materials used on the lower strength project Number 2.

The projects were many miles apart and all of the materials were from different sources. All of the materials, however, tested within our specification limits and therefore were acceptable.

To remedy defects in the design of concrete, the various elements must be investigated, one at a time. Therefore, in this series of tests, specimens were made using cements and aggregates in all possible combinations in order to show clearly the variation in strength due—

1. To the difference in the quality of the sand.
2. To the difference in the quality of the gravel.
3. To the difference in the quality of the cement.

Sand.—In mortar tests, Number 1 sand, as used in the paving work, gives a strength ratio of 123. Number 2 sand, used as in pavement, had a

strength ratio of 104. This difference in strength ratios is reflected in the tests of concrete, as shown in the following table:

TABLE 1

Variation in strength of concrete due to difference in quality of sand.

Made with	Pounds No. 2 weaker than		
	No. 2 Sand	No. 1 Sand	No. 1
No. 2 Cement, No. 2 Gravel	3141	3382	241
No. 2 Cement, No. 1 Gravel	3431	3739	308
No. 1 Cement, No. 2 Gravel	4202	4438	236
No. 1 Cement, No. 1 Gravel	4260	4711	451
Average	3760	4070	310

Gravel.—Number 2 gravel, partly crushed, recorded a loss of 19 per cent in the shot rattler. Number 1 gravel, not crushed, in the shot rattler shows a loss of 10.2 to 11.5 per cent. A somewhat higher rattler loss is expected with partly crushed gravel, but the test indicates that Number 2 gravel is somewhat weaker than Number 1 gravel. That there is a difference in strength of concrete made with each gravel, is apparent from the following table:

TABLE 2

Variation in strength of concrete due to difference in quality of coarse aggregates.

Made with	Pounds No. 2 gravel weaker than		
	No. 2 Gravel	No. 1 Gravel	No. 1
No. 2 cement, No. 2 sand	3141	3431	290
No. 2 cement, No. 1 sand	3382	3739	357
No. 1 cement, No. 2 sand	4202	4260	58
No. 1 cement, No. 1 sand	4438	4711	273
Average	3790	4035	245

Cement.—The following table shows the difference in strength of concrete on the two jobs directly attributable to the difference in quality of cement:

TABLE 3

Variation in strength of concrete due to difference in quality of cement.

Made with	No. 2 cement weaker than		
	No. 2 cement	No. 1 cement	No. 1
No. 2 sand, No. 2 gravel	*3141	4202	1061
No. 2 sand, No. 1 gravel	3431	4260	831
No. 1 sand, No. 1 gravel	3739	**4711	972
No. 1 sand, No. 2 gravel	3382	4438	1056
Average	3423	4402	980

*This cement, sand, and gravel gave average strengths of 2675 pounds on paving project Number 2.

**This cement, sand, and gravel gave average strengths of about 5000 pounds on paving project Number 1.

Conclusion.—1. Of the difference in strength of concrete on the two projects:

Table 1 shows sand to be responsible for 290 lbs. sq. in. 18%.

Table 2 shows gravel to be responsible for 241 lbs. sq. in. 15%.

Table 3 shows cement to be responsible for 1060 lbs. sq. in. 67%.

Total difference traceable to material 1591 lbs.

Actual difference in concretes made in laboratory with accurate control of water and uniform manipulation1570 lbs.

Actual difference in field concretes from the two jobs about.....2300 lbs.

Difference due to excess water and other variations about.....700 lbs.

2. By regrading the sand to a coarser curve, some of the difference due to low strength ratio of sand might have been eliminated. (Reference in this connection is made to tests of materials for another paving project, recently reported, in which 200 to 300 pounds was added to the strength of sand by regrading to a coarser curve.)

3. Number 1 sand and gravel can be considered of as good a quality as can reasonably be expected under favorable conditions. By bringing the quality of sand and gravel on the Number 2 job up to the quality of project No. 1 material, and by most accurate control of water in the mixture, the strength might have been increased about 1230 pounds. By substituting a stronger cement 1060 pounds might have been added.

4. This series indicates it is possible to predetermine the quality of concrete to be produced with any given combination of aggregates of a known quality. It also indicates the water cement ratio and the fineness modulus are not the only considerations in the proper design of concrete.

Concrete Road Maintenance

Suggestions for their care and maintenance made by the chief engineer of the Missouri Highway Department.

In connection with a course of instruction given to employees of the Missouri State Highway Department, B. H. Piepmeier, chief engineer of that department, gave suggestions for the care and maintenance of concrete pavements, of which the following paragraphs form a brief abstract.

The routine work of maintaining concrete pavements consists of filling the cracks and joints with bituminous material, repairing blow-ups, patching small holes and worn places, replacing broken sections, correcting sags and settlements, and performing the usual work of maintaining shoulders, ditches, guard rails, etc.

For filling cracks and joints he recommends a crew of three men equipped with a light one-ton or two-ton truck, a 60 to 100-gallon heating kettle mounted on wheels, a thermometer, two pouring cans, a long-handled ladle, a raking tool for cleaning cracks, a stiff broom and two or three shovels. The materials needed are bitumen, sand, and fuel for the heating kettle. As bitumen, the state is now using asphalt with a penetration of 85 to 100 at a temperature of 77 degrees and of such character as not to become brittle at zero degree. The same material mixed with sand forms a good mastic for filling the

larger expansion joints. The asphalt should never be heated over 350 degrees and should not be maintained at this temperature for a long period of time.

All dirt must be cleaned out of cracks before applying the filler. In filling old joints, remove the old filler down to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ inch below the surface of the concrete, using a sharp pointed raking tool followed by a stiff broom for cleaning out the crack and a hand bellows to remove the dust. The asphalt is poured into the crack until just rising over the edge and is immediately covered with coarse dry sand. More than this is not only a waste of asphalt but makes an unsightly wide strip.

Cracks and joints should be inspected frequently and usually need to be filled twice a year, in the spring when rising temperature squeezes the asphalt out of the crack, and in the fall when contraction opens it up again. The excess material squeezed out of a crack in the spring should be removed by cutting it flush with the surface by means of heated shovels.

It is frequently necessary, especially in a new pavement, to patch shallow depressions which have formed due to soft aggregate, lumps of clay or other foreign matter which found their way into the concrete during construction. The small holes or depressions should first be thoroughly cleaned, then covered with a thin coat of hot asphalt and filled with small pieces of stone or gravel well tamped in. More hot asphalt is then poured until it is flush with the surface and coarse dry sand sprinkled over the entire area and tamped in. Rock asphalt may be used instead of stone and asphalt. In this, as in all other cases, asphalt should be applied only to dry surfaces.

In making a large patch more than one inch deep, the sides of the hole should be trimmed with a chisel to a depth of not less than three inches, the edges thoroughly cleaned and free from dust. The edges of the hole are then thoroughly wet and new concrete applied, tamped thoroughly and the surface brought uniform with that of the surrounding pavement.

For repairing cuts in pavements or replacing areas which have blown up or otherwise been destroyed, the edges of the hole should be squared up and new concrete applied. The sub-base should be thoroughly tamped before new concrete is applied. If the soil is soft, it is desirable to tamp fine gravel or sand into it until a firm sub-base is obtained. The concrete used should be as nearly as possible the same in kind and proportioning of materials as that used in the original pavement; except that no mixture leaner than 1:2:3 should be used. After the concrete has been thoroughly tamped it is allowed to stand for from five to twenty minutes and then tamped again, and this repeated at intervals of from five to twenty minutes at least three times; the intervals between tamping being controlled by the rate at which the cement hardens. After the last tamping, the concrete should be surfaced and gone over with a wooden hand float. Cover the surface with damp canvas or burlap until the concrete has hardened; then with three or four inches of damp earth kept moist for at least seven days. Traffic should be kept off all small patches for at least fourteen days and off of large patches for at least twenty-one days.

Where there is heavy traffic or other conditions prevent excluding traffic for this length of time, a temporary patch can be made using bituminous material, the edges being trimmed down as before. The sides of the hole should be painted with a thin coat of bitumen and in it placed a mixture of bitumen and a well-graded mixture of sand and crushed stone or gravel not over $1\frac{1}{2}$ inches in diameter, using just enough bitumen to cover every particle of sand and stone. This is tamped thoroughly as in the case of concrete and then covered with an application of coarse, dry sand.

Mr. Piepmeier described a method of raising to grade a slab or slabs under which settlement has occurred by driving a tunnel across the road under the lowest edge of the slab, raising this by jacks and then solidly compacting between the raised slab and the subgrade sandy loam or other dry soil with good bearing qualities.

Joints on New Jersey Concrete Road

Last year there was completed in New Jersey a stretch of highway 32 miles long, forming a part of what is known as the Shore Road, which was built of concrete and contains one or two features that are worth mentioning.

One contract for about $5\frac{3}{4}$ miles was given to the State Department of Institutions and Agencies and built by convict labor.

The Shore Road is a popular road from New York and adjacent cities to Atlantic City, and it was very desirable to maintain traffic during construction. Before any concreting work was done, a 10-ft. gravel shoulder was built on each side of the road. The concrete was then built in two 10-ft. strips, making a 20-ft. pavement with a joint down the middle. While one strip was being laid, the other half of the road and the adjacent shoulder were used for traffic. When the first half had been completed and cured, this strip and the adjacent shoulder was opened to traffic and the second half of the concrete pavement was laid. This gave a 20-ft. roadway, allowing a line of traffic in each direction, during the entire construction.

The joints used in this work are described as follows by the Concrete Highway magazine: "A special feature of concrete road construction in the practice of installing joints was used on this work. It involved the use of the bituminous poured joint and the use of metal caps over premoulded joint where that material was used. The form or core for the poured joint is a built up board having collapsible sides of corrugated cardboard with solid cardboard center. Holes were punched in the board for dowel bars. A metal cap protected the top of the joint which was placed just a shade below the elevation of the side forms. After concrete had been deposited, struck off and finished over the joint, the finisher ran an edging tool on each side of the cap before removing it. Later, when the concrete had partially set up, the inside solid cardboard of the joint was pulled out by the use of a special pair of pincers,

which allowed the sides to collapse, facilitating their later removal. Bituminous filler was poured into the crevice before the road was opened to traffic. The use of a metal cap on premoulded joints allowed finishing, both hand and machine, to proceed right over the joints and precluded the necessity of trimming the material after the pavement was completed. It has an added advantage in that the cap holds the top of the filler straight and results in a cleaner-looking joint. Expansion joints which extended continuously through the two 10-foot strips were spaced at intervals of 45 feet."

Highway Work in South America

Information concerning certain phases of highway work in South America has been furnished to us by a correspondent who has recently returned from that country and whose interests are such as to cause him to take particular notice of matters of this kind. He states that, as yet, a very small amount of machinery is used in highway building in most of the South American countries. A few tractors are seen and a few machines of the Western Wheel Scraper Company, but most of the highway work is done with pick, shovel and wheelbarrow. The principal exception seen by the writer was a stretch of improved highway from Callao to Lima, Peru; and in addition, a small installation of road machinery at San Paulo, Brazil. Highway officials in seven of the South American countries visited stoutly maintained that conditions at present demand hand methods.

In Panama it was found that the government had spent approximately five million dollars in four years on highways.

In Peru there are no roads in Talara or Salaverry. But between Callao and Lima there is a highway about $7\frac{1}{2}$ miles long, 8 meters wide and 8 to $9\frac{1}{2}$ inches thick.

Building of highways in Chili across the Andes has been considered, but seems to be impracticable, one obstacle being the very severe snow conditions.

In Argentine Republic, highway transportation is confined largely to city limits. However, in the vicinity of Cordoba, there are a number of very good roads built of sand and gravel, waterbound macadam and stone.

Activated Sludge Notes

In a paper before the "Public Works, Roads and Transport Congress" in England last November, H. C. Whitehead, engineer of the Birmingham, Tame & Rea District Draining Board, suggested that activated sludge treatment, carried on for a shorter time than has generally been thought desirable, is an efficient means of removing colloidal solids, and is better than chemical precipitation because, when followed by sedimentation, the biological changes are more profound and far-reaching. Some of the advantages are that putrefactive changes in the clarified liquid are arrested, trouble from flies (psychoda) is much less, and colloidal matter is sufficiently reduced to greatly increase the capacity of sprinkling filters.

Separate re-activation of sludge is, he said, of distinct advantage, since only one-fifth to one-tenth

of the sludge needs to be returned to the sewage, and consequently only this amount needs to be reactivated. It is suggested that the fresher the sewage when it is treated, the better; also, that there may be an advantage in a certain amount of aeration before activation is started.

Effect of Size and Shape of Test Specimen on Compressive Strength of Concrete*

Result of tests made at Lewis Institute on cylinders from 1½ to 24 inches long and of various diameters, and on cubes and prisms.

By Harrison F. Gonnerman

Standardization of form of test specimen has played an important part in studies of concrete. The 6 by 12-in. cylinder is now generally used for compression tests; however, it is not always practicable to use this form, particularly for specimens cut from structures; therefore it becomes important to know the relative strength of concrete specimens of different sizes and shapes. Considerable data on the effect of size and shape of specimen are available for stone, masonry, piers, etc., but comparatively few tests have been carried out on concrete; in the tests reported no attempt was made to differentiate between different types of concrete.

The investigation reported upon in this paper was made to obtain more complete information on the compressive strength of concrete specimens of a wide range of shape and size when such factors as mix, consistency, grading and size of aggregate, and age at test were varied. The tests formed a part of the experimental studies of concrete and concrete materials carried out at the Structural Materials Research Laboratory through the co-operation of the Lewis Institute and the Portland Cement Association.

SUMMARY AND CONCLUSIONS

Compression tests were made at 7 days to 1 year on 1,755 concrete specimens in a study of the compressive strength of:

1. Cylinders 1½ to 10 in. in diameter and 2 diameters in length, when such factors as size and grading of aggregate, mix, consistency and age were varied over a wide range.
2. Cylinders 12 in. in length ranging from 3 to 10 in. in diameter.
3. Cylinders 6 in. in diameter ranging from 3 to 24 in. in length.
4. Cubes, 6 and 8-in.
5. Prisms, 6 by 2 and 8 by 16-in.

Most of the tests were made at 28 days on 1:5 and 1:3 concrete of relative consistency 1.10, using sand and pebble aggregate graded 0 — 1½ in. The relative strength of the different forms of specimen was compared with the strength of 6 by 12-in. cylinders from the same concrete.

The principal conclusions from the tests are:

1. The 6 by 12-in. cylinder generally used for compression tests of concrete, as recommended in the Standard Methods of Making and Storing Specimens of Concrete in the Field (serial designation: C 31—21) and in the Tentative Methods of Making

Compression Tests of Concrete (serial designation: C 39—21 T) of the American Society for Testing Materials, is a satisfactory form of specimen. However, because of the likelihood of non-uniform placing it is recommended that the use of this size of cylinder be limited to aggregates 2 in. or less in diameter.

2. The 4 by 8-in. or 5 by 10-in. cylinders are suitable for the smaller sizes of aggregate. The ratio of diameter of cylinder to maximum size of aggregate should not be less than about 3. For aggregates larger than 2 in., 8 by 16-in. cylinders or larger should be used.

3. For cylinders of length equal to 2 diameters, lower strengths were generally obtained with the larger cylinders. The decrease in strength with size of cylinder was not important for diameters of 6 in. or less; 8 by 16-in. and 10 by 20-in. cylinders gave 96 and 92 per cent. of the strength of 6 by 12 in. cylinders.

4. Concrete cylinders having a ratio of length to diameter of from 0.5 to 4.0 gave the following average strength-ratios at 28 days:

Ratio of length to diameter	0.5	1.0	1.25	1.5	2.0	3.0	4.0
Strength-ratio, percentage of strength of 6 by 12-in. cylinder	178	115	107	103	100	95	90

These strength-ratios agree with those reported by other investigators. The difference in strengths of cylinders having ratios of length to diameter between 1.5 and 2.5 was not important.

5. The 6- and 8-in. cubes tested at ages of 7 days to 1 year gave strengths averaging 18 and 13 per cent higher than 6 by 12-in. cylinders. The strengths for 6 by 12 and 8 by 16-in. prisms were lower at all ages than that for 6 by 12-inch cylinders; the strength-ratios averaged 93 and 91 per cent, respectively.

6. For all forms of specimens the compressive strength increased with age for moist curing. For cylinders and prisms of length equal to twice the diameter or width, the 7-day, 3-month and 1-year strengths averaged 52, 142 and 178 per cent of the 28-day strength for 1:5 concrete. The corresponding percentages for 6- and 8-in. cubes were 60, 129 and 165 per cent.

Roadside Trees in California

Systematic planting of trees for the beautification and preservation of the California State Highways started in 1920. At the end of the fiscal year 1922 there had been planted 100 miles of trees. Since that time, this mileage has been more than doubled,



ROADSIDE TREES NORTH OF BURLINGAME, CAL. SET OUT BEFORE SYSTEMATIC PLANTING WAS THOUGHT OF.

* From paper before American Society for Testing Materials.

and in addition there have been acquired a number of miles of recently planted trees by the transfer of roads from several of the counties.

On June first, 1924, the California State highway system carried a planted area of approximately 250 miles of road, or in other words, five hundred miles of recently planted trees. Generally, the trees are spaced at 50-foot intervals, placed alternately on the right and left sides of the roadway, with the necessary elimination for visibility at crossings and road intersections. In certain localities, trees are spaced about 50 feet apart on each side. The number of newly planted trees within the planted area ranges close to 30,000 and it is estimated that the older plantings throughout the state would duplicate this, both as to mileage and number of trees.

Care of these trees is in the hands of the highway maintenance forces, and it is found to be a task of no mean proportions. Last summer presented difficulties that were unusual and difficult to combat. The continued drought was instrumental in lowering the water table several feet below normal and below the root system of the trees. Due to this condition a majority of the trees depended for existence entirely on water that was applied to them from motor tanks. In spite of the many difficulties, 95 per cent of the older plantings have been held, and 75 per cent of the 1923 plantings are intact. Fortunately, considering the season, few trees were planted during the winters of 1923 and 1924 and as a result the loss is proportionately less.

Purified Water Preferable to Unpolluted

It is reported that a French scientist, Fernand Arloing, professor of bacteriology at the University of Lyons has, by a long series of experiments, determined, to his own satisfaction at least, that pathogenic bacteria are or may be afflicted by parasitic micro-organisms, and that these can be utilized to destroy the particular kind of bacteria on which they originally developed. Such parasitic organisms can be separated from their pathogenic bacteria and if placed in water or other media containing bacteria of this class, they would proceed to destroy such bacteria.

He finds that these micro-organisms are very much smaller than the ordinary bacteria and will pass through the minute pores of a porcelain filter.

Dr. Arloing suggests that it is the presence of such bacteriophages which causes individuals to be immune to various diseases communicated by bacteria. He believes that he has discovered that the water of certain streams or other bodies of water contains these parasitic micro-organisms and thus destroys any bacteria of which they are parasites which may reach such body of water. In this way, he accounts for the much more rapid disappearance of typhoid bacteria in certain rivers than in others.

He states that bacteriophages are found in the effluents of practically all water-works filters, and suggests that such effluents are therefore really preferable for drinking purposes to water which has never been polluted, in that the former furnish immunity from typhoid or any other disease, the bacteria of which have been removed by the filtration process.

Taste in Chlorinated Water

English experiments indicate that iodoform taste is caused by phenol in smoky fogs. Taste preventers and super-chlorination

The results of some recent studies relating to the purification of water, carried on in England by John C. Thresh and John F. Beale, were described by them in a paper read last December before the Institution of Water Engineers. Under the head of "Iodoform Smell and Taste in Chlorinated Water" the authors reported as follows: "Considering the purification of water by chlorine, everyone is aware that the greatest objection to this is the occasional odour and taste which develops, and which gives rise to erratic complaints, complaints which arise only from a limited number of those using the water. Some two years ago a waterworks troubled with these complaints put in a chemist to act under us to supervise the process, and after long and careful observation he discovered the cause and, we believe, also a remedy. He found that the complaints always followed certain atmospheric conditions and that water exposed acquired the odour and taste, whilst that shielded from these conditions did not. Finally he came to the conclusion that the substance giving rise to the odour was a "phenol," a constituent of smoke, or an allied body. This seemed so remarkable that a series of experiments were made in our laboratories which not only confirmed this, but also showed that one part of phenol in 5,000 million parts of water gave rise to taste observable by a few people, whilst stronger doses became more and more perceptible till everyone could detect first the taste, then the odour. Apparently the exposed water takes up a trace of this body from the air or from a fog or drizzle, sufficient to produce a taste which can only be detected by a few, or on occasions sufficiently strong to be detected by many.

"This odour only arises when there is a slight excess of chlorine over and above what is destroyed by the oxidizable matter in the water, and must not be confounded with the chlorine taste which is observed when chlorine is used in relatively considerable excess. This latter is easily removed by sulphurous acid or a sulphite or by potassium permanganate. Houston appears to think that permanganate will remove the iodoform smell and taste, but we are unable to confirm this with the waters we have experimented with, but we do find that the addition of an exceedingly small quantity of ammonia added with the chlorine appears to prevent the formation of this odorous compound. Mr. Adams, however, is continuing his observations and experiments, and hopes to have some interesting results to publish shortly.

Of the numerous water authorities using chlorine and under our observation, these complaints seem to be limited to those places where the water before or immediately after chlorination is exposed for a time to the open air, and we should be glad to know if any person has observed this iodoform odour or taste in a water which has not been so exposed. If the occurrence of this odour could be prevented, it would be a great boon, removing the one serious objection to the use of chlorination as a purifying agent.

In an article by the investigator above referred to, B. Adams, published in the "Medical Officer" in October, a description is given of the results of some experiments made in studying the taste of chlorinated water. It was found that one part of iodoform in 1,000 million parts of water gave a decided taste which could not be distinguished from that given by chlorinated phenol. A mere trace of alcohol or acetone with iodine in an alkaline solution will give the iodoform reaction. By adding 0.2 p.p.m. of iodine to water containing one p.p.m. of alcohol and acetone respectively, vile tastes appear on allowing the mixture to stand, predominantly iodoform. Therefore, should a water contain the necessary organic matter (which might be supplied by bacterial action and iodine) in the form of an iodide from which it could be liberated, an iodoform taste would arise on chlorination.

The effect of taste preventers appeared to be less effective than super-chlorination and de-chlorination. By merely doubling the normal chlorine dose, the water was converted from an undrinkable to a perfectly palatable one; while permanganate, even in comparatively high doses, ammonia followed by chlorine, and chlorine plus ammonia, all failed to prevent even an odor.

"An iodoform taste, therefore, can be produced by one or less parts of iodide in 200 million parts of water, the taste taking a fair amount of time to develop. Super-chlorination and permanganate will prevent its formation; permanganate will, but SO does not remove this taste."

Mosquito Control Work

Work being done by the several states in an effort to reduce the number of mosquitoes, both as a health measure and a preventive of annoyance by the pests.

The operations carried on in connection with attempted control of mosquitoes was the subject of a report by the Committee on Mosquito Control of the American Public Health Association, presented before the sanitary engineering section at the latest convention. The chairman of the committee was L. E. Jackson, executive secretary of the Hudson County Mosquito Extermination Commission, of New Jersey.

It was stated that operations had been carried on quite generally in eleven states, to a limited degree in ten states, while no control whatever had

been undertaken in the remaining 27 states. Of the eleven states in the first group, the most detailed information was furnished concerning New Jersey, Florida, Mississippi, Texas, Alabama, New York, Illinois, Virginia and Missouri. Mosquitoes were reported to have been unusually rampant in practically all sections of the country last summer, chiefly because of the rain in the northwest which provided breeding places, and the lack of rain in the south which intensified sewage pollution of streams with a resulting increase in Culex. In New Jersey it was found, apparently as a result of the wet, humid weather, that the life cycle of two or three species of mosquitoes was found to have been reduced from the usual period of seven or eight days to five days.

New Jersey spent about \$325,000 last year, approximately the same as the year before, in mosquito control work. The outstanding feature of the last two or three years has been the development of machinery for drainage operations. This year the state experiment station completed the development of a ditch cutter designed to cut the regulation straight-sided ditch which is the standard in the state. The cutting and tractor units are combined with one 45 horsepower plant, a 55 Holt tractor having been remodeled so as to provide caterpillars with 4-foot treads and a 15-foot wheel base upon which the cutting device is mounted. The cutting is done by 36 wheel buckets carried on an endless chain belt. The sod which is removed is broken up and spread over an area 30 feet wide, which it is believed will prevent it from being washed back into the ditch. A direct steel gear drive of great strength was substituted for the ordinary chain drive. The total weight of the machine is 12 tons, so distributed as to give a pressure of only 1½ lbs. per square inch. It can be operated by one man, although two are ordinarily used. It has cut ditch at the rate of 40 ft. per minute and a cost per foot of ditch a little less than ½c, as compared to 1½c for the type of machine formerly used, and 3c for hand work. The cost of the experimental machine was \$10,000 but it can probably be reproduced for about \$8,000. The ditch cleaning machine used in this state has also been improved, the cost of the improved machine being between \$4,000 and \$4,500. These machines were successfully used in five counties in New Jersey.

In Florida, an anti-mosquito association succeeded in having a bill passed by the last legislature enabling any community to organize a mosquito control district, the bill being similar to those of New Jersey and California. Two communities were preparing to avail themselves of this act. Several cities had already been doing mosquito control work. Thousands of acres of swampy and low land have been improved by hydraulic fill methods during the past year in connection with land development programs, while thorough drainage in connection with such programs is perhaps doing more for control of mosquitoes than all the educational propaganda of past years.

In Mississippi about forty towns are engaged in anti-mosquito operations, principally from the standpoint of malaria control, but also for elimination

of the mosquito as a pest. This state has the highest malaria death rate, but a marked reduction has resulted from work in several counties. Twelve counties have active full time health departments engaged in this work.

Many Texas towns are doing mosquito control work and the state department of health has an appropriation of \$10,000 for such work. The engineering division of the department directs the work through an expert who organizes local forces under municipal ordinances, the work being financed by the several localities. More or less work is done by more than 100 other communities and there has been a material reduction of malaria cases. The top-feeding minnow is used extensively. The subject is one of those taken up by the annual school of sanitarians, which was attended by about 500 last year. Thirty-six towns employ whole-time inspectors and 62 towns part-time inspectors. Several railroads are co-operating in mosquito eradication campaigns and it is expected that practically all railroads west of the Mississippi in Texas, Arkansas and Louisiana will soon be conducting such campaign or supporting health authorities in this work.

Information was furnished by Col. Jos. A. Le-Prince, senior sanitary engineer of the U. S. Public Health service, concerning the Mexican border campaign. This included 68 villages and towns in the triangular area between Brownsville, Del Rio and Corpus Christi. The chief problem was to prevent stegomyia breeding in containers. Inspection was made of 108,500 premises where 16,800 barrels were used for water storage. As a result of this, 64 per cent of these were eliminated and 86 per cent of those remaining were protected against breeding; 5,800 cisterns were under inspection of which 73 per cent were protected against breeding. In May, 1925, less than 1 per cent of all these containers were producing any kind of mosquitoes. This campaign has been conducted for the purpose of preventing yellow fever from entering the United States from Mexico, and has been a striking success.

In Alabama this work has been under way for ten years, largely through county health organizations. Regulations in 1922, controlling the impounding of water, have been rigidly enforced in 23 counties. Eleven hundred places have been stocked with top minnows.

In Georgia, 40 cities and towns are doing malaria control work.

In Kentucky the limited personnel of the board of health directs its attention to intestinal diseases rather than malaria. In Massachusetts, control operations have been carried on for a number of years in certain sections by a state society, chiefly by educational measures; although some salt marsh work has been done, notably on Cape Cod.

Three communities in Maryland have carried on anti-malaria work with satisfactory results.

In New York state, extensive control has been limited to Nassau Co., where a county commission has been working since 1916 along the same general lines as in New Jersey with annual expenditures ranging from \$50,000 to \$80,000. Anti-mosquito work in New York City has been limited during recent years by insufficient appropriations.

In Illinois, the 12 most southern counties are

classed by the state department of health as the "malaria belt," malaria control in which was begun in 1922 by the state. At present, 12 cities are conducting such campaigns. The Gorgas Memorial Institute has inaugurated an extensive campaign, organizing various committees into one unit. Last summer it conducted such a campaign in Chicago and its suburbs with very satisfactory results; the problem there being chiefly one of river and creek breeding because of the sewage received by these streams. House to house inspections by 400 boy scouts showed 40 per cent of the houses breeding mosquitoes. The sanitary district of Chicago expended \$25,000 in similar work.

In Virginia, 25 towns are doing control work. The cities of Norfolk and Portsmouth are especially guarding against breeding in the reserve water supplies. The only vector of malaria in that state breeds in ponds, and pond control has been found most effectively secured through fluctuation of the level, the water being held at as high a level as possible throughout the winter and lowered about June 15th, 1 foot or more until breeding is resumed, and then lowered another foot. Two or three lowerings of the surface, a foot at a time, has always been successful in controlling the breeding of anopheles.

In Missouri, mosquito control is practised only in the southeast section, generally by ditch maintenance.

In California, one of the first states to fight against mosquitoes, control operations are being carried on in 17 districts. The top minnow was introduced in 1922 with excellent results.

In Rhode Island, Providence and some other towns and cities have been carrying on control work, the state aiding in this by contributions amounting to \$40,000 in 1923 and \$20,000 in 1924.

In a number of the 27 states where there is no attempt at control, there seems to be no mosquito problem, although this does not apply to all the states.

Along the gulf coast of Texas, Louisiana, Mississippi, Alabama and Florida, an effort was made, with the aid of the Director of Entomology of the U. S. Department of Agriculture, to eliminate sollicitans because of its objection as a pest, in an effort to make the gulf coast more attractive to visitors and residents.

Attention was called by the committee to the desirability of mosquito prevention work in connection with tourist camps—a field which has apparently been overlooked so far.

Emphasis was placed by the report upon the necessity for educating individual householders to eliminate breeding places on their premises as a necessary feature of mosquito control work. Such educational work may be carried on by means of motion picture reels, mosquito manuals in public schools, advertisements in local newspapers, etc. Boy scouts have been used for inspections in some states, police in others.

As interesting incidents, the report cited finding of sollicitans on a passenger steamer five miles off the Massachusetts coast; almost intolerable annoyance by mosquitoes of the McMillan polar expedition on the east coast of Labrador, and the report of five million cases of malaria in Russia during 1924.

Recent Legal Decisions

BUILDING INSPECTOR CANNOT GRANT PERMIT FOR LOTS OTHER THAN THOSE SPECIFIED IN RESOLUTION

The Colorado Supreme Court holds, *City and County of Denver v. Spiegleman*, 231 Pac. 204, that a building inspector could not issue a permit for building on lots other than those specified in the council resolution because he thought he was carrying out the intent of the council.

INSUFFICIENT EVIDENCE OF DEATH OF CATTLE FROM POLLUTION OF WATER FROM SEWAGE DISPOSAL PLANT

In an action for injury to and death of cattle alleged to have been caused by the pollution of water into which the defendant town had permitted sewage to escape from its disposal plant, the Iowa Supreme Court held, *Kearney v. Town of De Witt*, 202 N. W. 253, that the plaintiff had the burden of proving, first, that his cattle drank of this water, and that it contained the germs of the disease from which the cattle suffered; second, that these disease germs were placed in the water by the conduct of the town.

No analysis of the water was made, and there was no testimony, as a fact or as an opinion, that the water contained the germs. The evidence on the second point was equally uncertain. There was no dispute but that the disposal plant did not operate properly, and overflowed, and the sewage passed into a tile outlet and thence into a drainage ditch; but it was equally probable that the germs might have been carried into the drainage ditch by lines of tile coming from, or by the overflow water from, the stockyards and the streets of the town, as that it came in by reason of the overflow from the disposal plant. It was therefore held that the evidence was insufficient to support a verdict for the plaintiff, and judgment for plaintiff was reversed.

PROCEDURE FOR CONSTRUCTION OF SIDEWALK, CURB AND GUTTER

In May, 1921, a city in Kansas, of the third class, by ordinance condemned a sidewalk, curb and gutter in the business part of the city and provided for constructing, on a different grade, a new sidewalk, curb and gutter according to "grade and plan of survey" on file with the city clerk, and taxing the entire cost to abutting lots. No grade for the street had ever been established, and there were no plans of survey. In a suit by an abutting owner to enjoin the work, the Kansas Supreme Court held, *Decker v. City of Pleasanton*, 231 Pac. 330, that under the Kansas statutes: (1) The construction of the curb and gutter could not be provided by ordinance, but must be by petition, or by resolution with time for protest, as for pavement. (2) The grade of a street should be established by ordinance. (3) The cost of grading should be paid by the city at large. (4) Since the cost to the lot owner of the sidewalk included an unascertainable sum for grading which was improperly taxed to him, the work should be enjoined.

TAKING AWAY LATERAL SUPPORT IN GRADING STREET NOT A TAKING OF PROPERTY

The Washington Supreme Court holds, *Fenton v. City of Seattle*, 231 Pac. 795, that where a city, in

grading a street, excavated along the front line of abutting lots to a depth of 12 feet or more, causing the surface of the lots to slide, all the city did was to take away the lateral support, which might be a damage for which the lot owners were entitled to compensation, but was not a taking of any portion of their lots.

INJUNCTION OF PARTLY PERFORMED CONTRACT FOR CONSTRUCTION OF WATER WORKS DENIED

Injunction having been denied against performance of a contract for the construction of city water-works with named contractors on the ground that the certified check which accompanied their bid was insufficient, the Washington Supreme Court, *Goetz v. Russell*, 232 Pac. 300, dismissed an appeal from the judgment, it appearing that the plaintiffs did not seek damages and could not suffer as taxpayers, because the cost of construction was being raised out of a special fund provided by the revenues of the city's public water system, and the contractors at the time of appeal had spent large sums, partly performed the contract, constructed a power line and acquired a right of way for a railroad.

LOWEST RESPONSIBLE BIDDER—DISCRETION OF BOARD

A city asked bids for gathering ashes and rubbish. The city awarded the contract to one not the lowest bidder in money. The Pennsylvania Supreme Court held, *Hiorth v. City of Chester*, 127 Atl. 836, that the "lowest responsible bidder" does not necessarily mean the lowest bidder in dollars; nor does it mean the board may capriciously select a higher bidder regardless of responsibility or cost. What the law requires is the exercise of a sound discretion. In this case both bidders had previously engaged in municipal contracting and were personally known to the members of the council. In view of this and of the fact that at the same time the council awarded a contract to collect the city's garbage to the lowest bidder in money on the present contract at a price much lower than the bid of the successful bidder on the present contract, it was held that the city had not abused its discretion.

CONSTRUCTION OF COST PLUS CONTRACT

A government cost plus contract for the construction of certain public works during the war provided for monthly payments upon statements to be then made up by the contracting officer and the contractor, the statements so made and all payments thereon to be final and binding upon both parties, except as provided in another article, which provided for the reference of disputes to the officer in charge of cantonment construction, with right to the contractor to submit any decision to the Secretary of War. No disputes were referred to such officer. The federal district court for eastern South Carolina holds, *United States v. Hardawa Contracting Co.*, 3 Fed. (2d) 163, that the provision that the monthly statements and payments thereon were final and binding was not modified by any other provision of the contract.

MONEY DUE ROAD CONTRACTOR CANNOT BE GARNISHEED AS EARNINGS OF EMPLOYEE OF COUNTY

The federal district court of Kansas holds that a road construction contractor occupies the relation of an independent contractor with the county, and is not an employee or officer of the county in the sense in which such terms are employed in Laws Kan. 1919, c. 237, authorizing the garnishment of earnings of officers and employees. Money due the contractor from the county under the road contract is money due under the terms of an independent contract, and not earnings due it for personal services as an officer and employee of the county, and the county could not be garnished therefor.—*Citizen's State Bank v. Standard Engineering & Const. Co.*, 2 Fed. (2d) 308.

PRESUMPTION THAT ABUTTING PROPERTY BENEFITED BY PAVING IMPROVEMENT

The Louisiana Supreme Court holds, *Delahoussaye v. Board of Trustees of New Iberia*, 103 So. 152, that when a municipality, duly authorized by statute or by its charter, undertakes to pave one of its streets or a section thereof, it should be presumed to have found that the property abutting on the contemplated improvement will be benefited by it; and the court would only be justified in interfering with such discretion by injunction upon allegations showing facts which, if proved, would warrant the conclusion that the improvement will not benefit the abutting property, and not upon the mere allegation that the improvement will not be beneficial.

BOND TO COVER LABOR AND MATERIALS FOR PUBLIC WORK DOES NOT COVER MERCHANDISE SOLD TO OUTSIDE PARTIES

The Mississippi Supreme Court holds, *Watkins v. United State Fidelity & Guaranty Co.*, 103 So. 224, that a bond executed under the provisions of section 1, c. 217, Laws of 1918, conditioned, as required in such section, to pay any person who has furnished labor or materials used in the construction of public work which had not been paid for, does not cover accounts for groceries and merchandise furnished a commissary, which commissary is operated by the principal contractor in aid of the work, where the commissary was operated for profit, and part of the merchandise sold to others than the laborers, the amount of such sales to outside parties not being shown.

MUNICIPAL PUBLIC AUDITORIUM HELD A "PUBLIC PURPOSE"

The North Carolina Supreme Court holds, *Adams v. City of Durham*, 189 N. C. 232, 126 S. E. 611, that the erection of a public auditorium, while it may not be a necessary expense, is a public purpose, for which a city, having funds on hand, may use such money, both by the general law and the applicable provisions of the charter. C. S. §§2673, 2786 and 2787, subsecs. 3 and 4.

STATUTE REQUIRING OWNER TO FILE ESTIMATE OF DAMAGES FROM CHANGE OF GRADE

The West Virginia Supreme Court of Appeals holds, *White v. City of Charleston*, 126 S. E. 705, that it is within the legislative power to require an abutting owner on a street in a municipality to file with the city, within a designated time after notice,

an estimate of the damages which in his opinion he will sustain by reason of a proposed change of grade, as a condition precedent to maintaining suit for damages after the improvement is ordered and made; provided that the time designated is not so short as to deny the property owner a fair and reasonable opportunity to present his estimate and protect his remedy, and the requirement is not otherwise unreasonable and arbitrary. In pleading such a statute as a bar to an action by the land owner, the plea should aver sufficient facts to show that the city in proceeding thereunder has not interpreted and applied the statute so as to render it unreasonable and arbitrary.

TEMPORARY CLOSING OF STREETS BY PLACING OBSTRUCTIONS THEREIN

The Georgia Court of Appeals holds, *City of Blakely v. Funderburk*, 125 S. E. 602, that a city has the right to close temporarily one or more of its streets for repairs or for the safety and convenience of the public, by placing obstructions therein; and where such obstructions are temporary and reasonable in their character, the city will not be liable for personal injuries resulting from a person driving against such obstructions, unless it further appears that the city failed to exercise ordinary care and diligence in safeguarding the obstructions.

ENGINEER'S CONTRACT FOR FIXED PERIOD FOR PLANS FOR PUBLIC WORKS HELD ULTRA VIRES OF CITY

The Louisiana Supreme Court holds, *Kirkpatrick v. City of Monroe*, 102 So. 822, that a city authorized to erect for its own needs a system of water-works or an electric light plant may, if it should undertake such work, contract with an engineer to plan and supervise the construction of the system or plant. But "this power is such that upon the completion of the improvement the contract must end, for the power is merely an incident to the power to make the improvement." It holds that an engineer's contract with a city for a period of four years to make plans, specifications and recommendations for betterments and extensions in, and addition to, the utilities and public works of the city, the city binding itself to pay the amount stipulated by monthly installments, was not authorized by the city's charter or any state law.

INJUNCTION OF PAVING PROJECT REFUSED

The Florida Supreme Court, in *Cawthon v. Town of De Funiak Springs*, 102 So. 250, denied injunction to restrain the municipality from so paving the surface of a street opposite complainant's store lot as to leave an unpaved space of about four feet between the paved sidewalk and the curb of the street pavement, for the reason that the complainant's rights did not appear to be unduly invaded by an arbitrary or unreasonable change in the grade of the street so as to injure complainant's abutting property beyond the reasonably necessary requirements of the public in the use of the street, and a contemplated or resultant negligent or arbitrary trespass or injury to the complainant's premises could not be assumed.

NEWS OF THE SOCIETIES

Feb. 17-19—ASSOCIATION OF HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES. Annual meeting at Syracuse, N. Y.

Feb. 22-23—AMERICAN CONCRETE PIPE ASSOCIATION. Annual convention at Chicago.

Feb. 23-26—AMERICAN CONCRETE INSTITUTE. Annual convention at the Sherman Hotel, Chicago, Ill.

March 29-April 1—NATIONAL CONFERENCE ON CITY PLANNING. Annual meeting at St. Petersburg and West Palm Beach, Fla.

March 3-5—CANADIAN SECTION, AMERICAN WATER WORKS ASSOCIATION. Meeting at St. Catharines, Ont.

June 7-11—AMERICAN WATER WORKS ASSOCIATION. Forty-sixth annual convention at Buffalo, N. Y.

INTERNATIONAL CITY MANAGERS ASSOCIATION

This association held its annual meeting at Grand Rapids Nov. 17th, 18th and 19th, with about 120 delegates present. Secretary John G. Stutz stated that 21 additional cities had adopted the city manager form of government, giving a total of 358 in 35 states. The financial affairs of the association are in good condition, with assets over \$6,000. It published two magazines and has a budget of \$21,346. The secretary recommended appointing committees on research and on city manager apprenticeship. The service committee also recommended a committee on city charter improvements and one on research into civil service regulations.

Officers for the coming year were elected as follows: as president, Harrison G. Otis, city manager of Clarksburg, W. Va.; as vice-president, John N. Eddy, city manager of Berkeley, Cal., and as secretary, John G. Stutz of Lawrence, Kansas. Colorado Springs, Colo., was selected for next year's place of meeting.

SAN FRANCISCO SECTION, A.S.C.E.

At the annual meeting of this section on December 15, Prof. B. A. Etcheverry was elected president, and W. H. Kirkbride vice-president.

KANSAS SECTION, A.S.C.E.

At the annual meeting of this section on December 10, W. V. Buck was elected president; P. L. Brockway, vice-president, and F. W. Epps, secretary-treasurer.

DAYTON SECTION, A.S.C.E.

At the annual meeting of this section on December 14 J. K. Grannis was elected president; F. J. Cellarius and N. Q. Sloan, vice-presidents, and C. H. Eiffert, secretary-treasurer.

MINNESOTA SECTION, A.W.W.A.

At the annual meeting of this section on November 13 J. A. Childs was elected chairman; Felix Seligman, vice-chairman; Arthur F. Mellon, secretary-treasurer.

BOSTON SOCIETY OF CIVIL ENGINEERS

The Sanitary Section, on February 3, will listen to a paper on "Chlorina-

tion of Water and Sewage" by Earle B. Phelps, professor of sanitary science at Columbia University. Prof. Phelps, about fifteen years ago, delivered before this society one of the first papers to be presented on this subject in the United States.

On January 27 Dr. George E. Vincent, president of the Rockefeller Foundation, will address the society on the subject of "The Engineer and Public Health."

ILLINOIS SECTION, A.S.C.E.

At its meeting on January 5 this section elected the following officers: Chairman, J. N. Hatch; secretary-treasurer, W. D. Garber.

KANSAS SECTION, S.W. W.W.A.

Kansas water works men attending the annual three-day course in water works engineering conducted by the University of Kansas last December organized a Kansas section of the Southwest Water Works Association, electing R. J. Paulette president, B. L. Ulrich, D. A. McGinnis, L. B. Mangum and Clyde B. King vice-presidents, and Prof. E. A. Boyce secretary-treasurer.

AMERICAN ROAD BUILDERS' ASSOCIATION

More than sixteen thousand registered at the Road Show in Chicago. The number attending the meetings of the association was not known definitely, but the rooms were crowded at every session of each section, Engineering and Construction. During the business session on January 14 resolutions were adopted endorsing a bridge over the Panama Canal, the principle of simplification and standardization, the merit system in the employment of employees in public works departments, affiliation with the International Road Congress, and Federal aid, requesting that the interstate highways selected by the Joint Board be designated by name as well as number, and conferring honorary membership on W. Rees Jeffreys, chairman of the British Roads Improvement Association.

U. S. CIVIL SERVICE EXAMINATIONS

The United States Civil Service Commission states that there is immediate need for additional design, detail, and copyist draftsmen for hull work at the New York Navy Yard. Salaries range from \$8.08 to \$10.16 a day for design draftsmen, and \$5.84 to \$7.60 a day for detail draftsmen, while copyist draftsmen obtain from \$4.04 to \$5.04 a day. The commandant of the yard can also make use of a number of mechanical draftsmen, structural-steel draftsmen, ship piping draftsmen or ship-ventilation draftsmen. Full information may be obtained from the

secretary of the second U. S. Civil service district, Customhouse, New York.

Chief Engineering Inspector-Superintendent; Principal Engineering Inspector-Superintendent. Receipt of applications for these positions will close on January 26. To fill vacancies in the Bureau of Public Roads, Department of Agriculture. Entrance salaries \$2,400 and \$2,100, respectively, which may be advanced without change in assignment up to \$3,000 a year for the former and \$2,700 a year for the latter. Duties of Chief Engineering Inspector-Superintendent consist of technical engineering or inspection work; of the Principal Engineering Inspector-Superintendent, to supervise construction work, supervising forces of men, establishing and maintaining amicable relations with local authorities, etc.

Engineering Aid. Applications will be received until January 30. To fill vacancies in Interstate Commerce Commission. Entrance salary is \$1,680 with advancement in pay without change in assignment up to \$2,040 a year. Duties consist of the calculation and classification of land areas and related work as required.

Junior Aeronautical Laboratory Draftsman, Aeronautical Laboratory Draftsman and Principal Aeronautical Laboratory Draftsman. Applications will close February 9. To fill vacancies under the National Advisory Committee for Aeronautics. Entrance salaries are \$1,320, \$1,680 and \$2,100, respectively, which may be advanced without change in assignment up to \$1,680, \$2,040 and \$2,700 a year. Duties involve the designing and drawing of mechanical appliances for instruments and their details used in the conduct of the laboratory of the Research Committee.

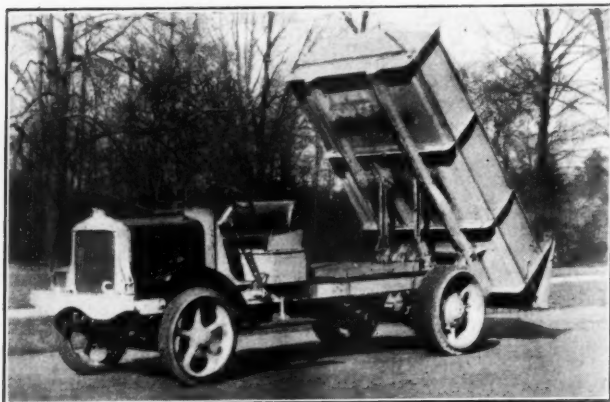
Principal Topographic Draftsman; Topographic Draftsman; Junior Topographic Draftsman. Receipt of applications for these positions will close January 26. To fill vacancies in the Departmental Service. Entrance salaries are \$2,100, \$1,680 and \$1,320, respectively, which may be advanced without change in assignment up to \$2,700, \$2,040 and \$1,680. Duties are to perform the responsible work of a principal topographic draftsman, such as the making of projections; making geodetic computations and hydrographic or topographic maps; to make occasional field surveys when necessary, and to perform related work as required. Duties of topographic draftsman, under supervision, are to perform topographic work, including drawing on lithographic metal plates, preparing hydrographic or topographic maps, etc. Duties of junior topographic draftsman, under immediate supervision, are to perform elementary and subordinate topographic drafting work, including copying, etc.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

NEW WHITE TRUCK

The White Company of Cleveland announces a new heavy duty dump truck known as Model 52 D, which is along the general lines of 45 D but with some improvements. It has an auxiliary transmission affording the equivalent of five speeds, with extra low-gear pulling power for hill climbing and exclusive White double reduction gear drive. It also has an improved oiling system. Other new features are large, tubular type radiator;



NEW WHITE MODEL 52D.

Showing high dumping angle, hoist mechanism, rigid lift arms and new radiator and bumper.

spring cradles on the frame; a wide, heavy pressed steel bumper; heavier easy-working steering gear; an air temperature regulator that saves fuel and adds to engine efficiency; heavy springs; reinforced frame of chrome nickel steel, and brakes with drums of a special metal for insuring quicker and certain stopping. The wheel base of Model 52 is 156 inches. Solid tires 36x6 front, 40x12 rear are standard equipment.

ERIE GAS-AIR SHOVEL

The Erie Steam Shovel Co., Erie, Pa., announces that it is going into quantity production of its gas-air shovel which it claims combines the convenience of gasoline fuel with the quicker positive action of a steam engine. This shovel has no reversing

friction clutch in either crowding, swinging, or hoisting train, the crowd and swing being obtained by direct connected engines running on heated compressed air. A 4-cylinder Waukesha gasoline engine, 5¾ inches bore by 8 inches stroke, drives the hoist direct. When its full power is not being used for hoisting or traveling, the power is stored as compressed air for use in crowding and swinging, until the air storage tanks reach maximum pressure. Air is piped direct from the

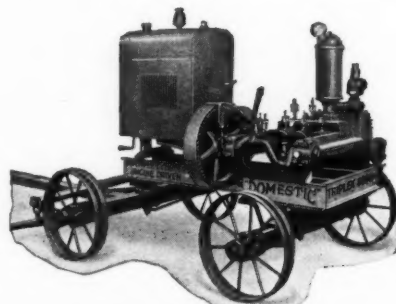
compressor to the crowding and swinging engines, with two large storage tanks to maintain the pressure. On its way to the engines the air is heated to above 400 degrees F. by utilizing the exhaust heat of the gas engine, this heating increasing the volume of the compressed air 75 per cent.

It is claimed that, whereas most power shovels use approximately 40 per cent. of the total power for driving

the crowd and swing, this is reduced to 25 per cent. in the Erie gas-air engine. Largely as a result of this, the manufacturers claim that these engines are averaging only 5 to 6 gallons of gasoline per 100 cubic yards dug. No time is lost in waiting for crowding or swinging clutches to take hold. The direct-connected air engine is said to give a delicacy of touch that permits accurate placing of the dipper. The entire machine is controlled by three throttle valves. The compressed air is used for starting the gasoline engine and also is available for rock drilling, pumping, riveting or any kind of air tools.

DOMESTIC FORCE PUMP

The Domestic Engine & Pump Co., of Shippensburg, Pa., provides for con-



TRIPLEX PUMP UNIT.

tractors a Domestic triplex force pump mounted on a steel wheel truck and useful for pile jetting and for purposes where water is required under pressure. Domestic pumps are designed so that power may be derived from gasoline engine, steam engine or electric motor. The standard portable triplex pump is gasoline engine driven, a 15 horsepower four-cylinder industrial type engine being used. The pump has 6 in. stroke, the diameter of the plunger either 3, 3½ or 4 in., giving a capacity of 85, 115 or 150 g.p.m., the working heads corresponding to the three capacities being 175 lbs., 130 lbs., and 100 lbs. respectively, gauge pressure. For jetting piles the 4 in. plunger is recommended.

WALTER SNOW FIGHTER

The Walter Motor Truck Co., Long Island City, N. Y., manufactures what it calls the "Walter Snow Fighter," a tractor snow plow using a front push blade to remove the deep snow and a center scraper blade for cleaning the snow and ice down to the pavement. Both front and center blades can be swung to either side. The power used is the Ricardo head motor. There are five forward speeds and the tractor develops 1,200 pounds push in high gear and 10,000 pounds in low gear. It is claimed that average snowfalls can be cleared with the tractor traveling 15 to 20 miles per hour.

Maximum traction is obtained by positive driving of all four wheels through automatic lock differentials. The snow fighter may be equipped

(Continued on page 38)



ERIE GAS-AIR SHOVEL ON ROAD WORK.



WALTER SNOW FIGHTER IN ACTION.

NEW CATALOGS

BURNS & McDONNELL PUBLICATIONS

The Burns & McDonnell Engineering Company, of Kansas City and Los Angeles, has begun issuing a monthly publication which it calls the "Bench Mark." It is distributed only among the members of the organization.

ARMCO CULVERTS

The Armco Culvert & Flume Manufacturers' Assn., of Middletown, Ohio, has published a bulletin entitled "Reducing the Cost of Culvert Placement," which describes a method of jacking corrugated culverts through existing embankments. 16 pages illustrated with photographs and diagrams.

DORR COMPANY CALENDAR

The Dorr Company of 247 Park Avenue, New York City, has issued an attractive wall calendar which they will be pleased to send direct to any one interested.

GAUNTT CHEMICAL FEEDERS

The W. J. Savage Co., of Knoxville, Tenn., publishes a 15-page pamphlet describing the Gauntt dry feeders for use in water purification plants for feeding lime, alum, soda ash or any dry pulverized material. Describes the parts and gives a partial list of 78 cities in which they are used.

LUBRICATING FIRE APPARATUS

The Ahrens Fox Fire Engine Co., of Cleveland, Ohio, publishes a 32-page pamphlet entitled "Correct Lubrication of Ahrens Fox Fire Apparatus" which describes and illustrates the various parts in this apparatus which need lubrication and gives the kind and amount of oil needed at each place. The pamphlet was prepared in collaboration with the Vacuum Oil Company of New York, whose oil is recommended for the purpose.

CENTRIFUGAL AIR COMPRESSORS

The General Electric Co., of Schenectady, N. Y., describes single-stage centrifugal air compressors suitable for ventilation, pneumatic conveying, and so forth.

INDUSTRIAL CONTROL CATALOG

The General Electric Co., of Schenectady, N. Y., has published a 160-page catalog furnishing information on representative lines of industrial control manufactured by that company, abundantly illustrated.

VIBROLITHIC BOOKLET

The American Vibrolithic Corporation, Des Moines, Ia., has published a 20-page booklet, profusely illustrated, giving a complete list of communities in which vibrolithic has been laid.

PENNSYLVANIA AIR COMPRESSORS

The Pennsylvania Pump & Compressor Co., of Easton, Pa., in bulletin No.



An Account of Stewardship

FIFTY years ago Dr. Alexander Graham Bell was busy upon a new invention—the telephone. The first sentence had not been heard; the patent had not been filed; the demonstration of the telephone at the Centennial Exposition had not been made. All these noteworthy events were to occur later in the year 1876. But already, at the beginning of the year, the basic principle of the new art had been discovered and Bell's experiments were approaching a successful issue.

The inventor of the telephone lived to see the telephone in daily use by millions all over the world and to see thousands of developments from his original discovery.

If he had lived to this semi-centennial year, he would have seen over 16,000,000 telephones linked by 40,000,000 miles of wire spanning the American continent and bringing the whole nation within intimate talking distance. He would have seen in the Bell System, which bears his name, perhaps the largest industrial organization in the world with nearly \$3,000,000,000 worth of public-serving property, owned chiefly by an army of customers and employees.

He would have seen developed from the product of his brain a new art, binding together the thoughts and actions of a nation for the welfare of all the people.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY AND ASSOCIATED COMPANIES



IN ITS SEMI-CENTENNIAL YEAR THE BELL SYSTEM LOOKS FORWARD TO CONTINUED PROGRESS IN TELEPHONE COMMUNICATION

126 describes duplex single-stage and 2-stage cross compound air compressors.

LOCK JOINT CONCRETE PIPE

The Lock Joint Concrete Pipe Co., Ampere, N. J., has published the handsomest catalog which has reached this office for a long time. It contains 80 pages, mostly photographs of the making and laying of lock joint reinforced concrete pipe, with descriptions of both regular and special constructions. It is bound in a stiff cover handsomely illuminated.

CONTRACT BONDS

The Surety Association of America, New York City, has published a 62-page pamphlet entitled "How Can Contract-Bond Conditions Be Improved?"

SNOW REMOVAL PRACTICE

The Good Roads Machinery Co., Kennett Square, Pa., in "The Handbook of Snow Removal Practice" gives information concerning snow removal, the necessity for it, and methods of organizing for and practicing snow removal. Forty-eight pages, well illustrated.

(Continued from Page 36)
with either sand and gravel body, special garbage body, flushing tank, or platform body, making it useful during the entire year.

THE DEODORIZATION OF NOXIOUS GASES

The Wallace & Tiernan Co., of Newark, N. J., announce that they are now in a position to offer the Henderson-Haggard Process for the deodorization of noxious gases by means of liquid chlorine. This process, developed by Professor Yandell Henderson and Dr. Howard Haggard, both of the faculty of Yale University, has been in successful operation since 1921 for the deodorization of organic gases. Wallace & Tiernan Co., Inc., has always manufactured the control equipment necessary for the proper installation of the process and they recently acquired an exclusive license covering its installation in North America.

The process consists of the proper admixture of chlorine and moisture to the gases at a point sufficiently prior to their final discharge to insure complete mixture and eliminates practically all organic odors and permits odor-producing establishments, such as rendering plants, garbage disposal plants, packing plants, soap factories, tallow factories, fish houses, glue factories, and the like to operate in congested areas.

There are scores of installations in successful operation deodorizing various types of gaseous effluents in an entirely satisfactory manner.

BUCYRUS 120B SHOVEL

The Bucyrus Co., South Milwaukee, Wis., has recently placed on the market a 4-yd., full revolving shovel which it claims to be a complete innovation in shovel design. It is built to combine the speed of action of the railroad type shovel with even greater ruggedness and power than is found in that type, 4-yard dipper capacity, full revolving swing, and the mobility of single truck caterpillars.

This shovel has a dumping height of 20 feet and radius 36 feet. The boom is 29 feet long and the rear end radius is 17 feet. Ruggedness and efficient operation with freedom from interruptions in operation were aimed at throughout. It includes new features in steam shovel

design such as a firebrick arch and superheater. The electric machine is equipped with Ward-Leonard direct current, generator field control.

RAYMOND COMPOSITE PILES

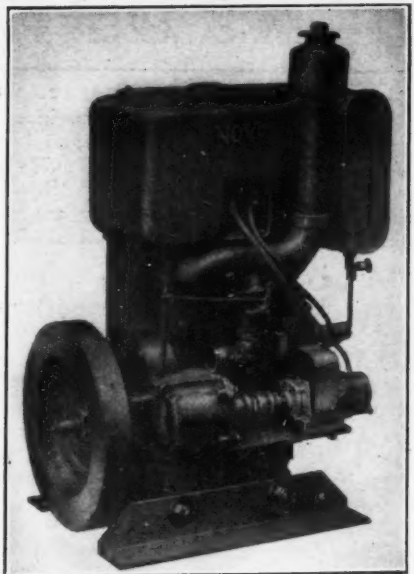
The Raymond Concrete Pile Co. of New York, has developed a composite pile for use where long piles are required and permanent ground water level exists within a comparatively short distance below the surface. Under these conditions, it is cheaper and perfectly safe to use wood for that portion of the pile that is permanently submerged. The Raymond composite pile consists of a wooden pile for this lower section, on which is superimposed a Raymond concrete pile, the special feature being the joint between the two which will insure sufficient strength and rigidity.

Before it is driven, the wooden pile is provided with a tenon approximately $9\frac{1}{2}$ inches in diameter and 18 inches long, in the center of which is imbedded a hollow steel socket secured by a steel pin extending through both tenon and socket. The socket has a heavy internal thread which receives the threaded end of a deformed bar, which is screwed into the socket after the wood pile has reached its final position and before the concrete is placed, serving to lock the wood and concrete together. A Raymond core which is encased in a spirally reinforced steel shell acts as a follower to drive the wood pile to the desired depth. The core is then collapsed and withdrawn, leaving the shell in the ground to be filled with the concrete.

NOVO GASOLINE POWER UNIT

The Novo Engine Co., Lansing, Mich., has just brought out a new 2-cylinder, 3 to 6 h.p., 4-cycle L head gasoline engine unit, hopper or radiator cooled. It has an independent drive shaft which can be placed on either side of the engine and furnished to rotate in either direction and at several different speeds varying from 400 to 1,800 r.p.m. The crank shaft is opposed throw type, eliminating crankcase pressure and making a well balanced engine. The drive shaft is gear driven from the crank shaft.

Standard equipment consists of Split-dorf high tension magneto and Zenith carburetor, fuel tank and cooling



NOVO UF, 3 H.P. TO 6 H.P., TWO-CYLINDER ENGINE.

system. There are two cylinders of 3-inch bore and 4 inch stroke and three $1/8$ inch piston rings per piston. The flywheel is 13 inches in diameter. The pulleys are either 8 in. or 10 in. diameter and 6 in. face.

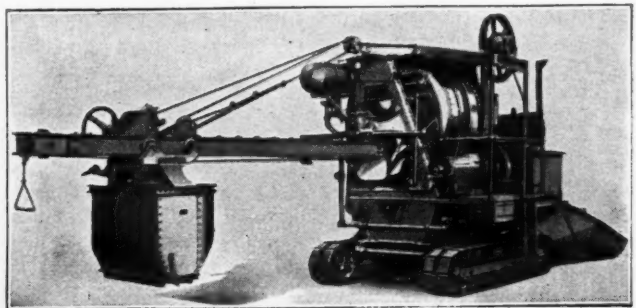
SMITH 27E PAVES

The T. L. Smith Co., Milwaukee, Wis., exhibited at the 1926 road show a new 6-bag 27E paver, which it claims will give more than 25 per cent. greater daily output than the standard 21E, with a very small additional investment in mixing, trucking and batch proportioning equipment.

The new machine retains the general features of the Smith Company's construction, including rapid and easy handling, and several new refinements. The Waukesha type DU motor has been adopted. The overall width has been reduced to make it the narrowest of any paver and particularly suitable for half width road and alley paving. The hoist drum is grooved to prevent the cable climbing. The skip saddle has been changed to structural steel to give it greater resistance to twisting. A new $3\frac{1}{2}$ inch water valve has been added which gives an unequalled rapidity of discharge of water from the measuring tank to the mixing drum.



BUCYRUS 120-B ELECTRIC SHOVEL IN ROCK QUARRY



SMITH 27-E PAVES WITH FULL-LENGTH TRACTION; GASOLINE DRIVE; BOOM AND BUCKET.